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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

Contents - January 1957

(18,300 copies of this issue printed)

200,000 kw. Reheat Boiler Design

for the Hydro-Electric Power Commission of Ontario, Richard L. Hearn Station

F. W. Cranston,

Sales Manager, Babcock-Wilcox & Goldie McCulloch Limited, Galt, Ont.

M. G. Ireland,

Asst. Contract Manager, Babcock & Wilcox Co., Barberton, Ohio.

Read at the 70th Annual General and Professional Meeting of the Engineering Institute of Canada, Montreal, May 1956

Many new problems in the last ten years have caused rapid change in the design of boiler units. The authors discuss some of the factors involved and describe the considerations that led to the design of the 200,000 kw. reheat boiler (no. 5) for Ontario Hydro's Richard L. Hearn Station.

BY WAY OF introduction it may be well to mention a few reasons why Canada's phenomenal industrial growth during the past fifteen years has not, up to 1956, justified a decision to install a thermal station equipped with units larger than 100,000 kilowatts capacity.

The greatest concentrations of population and of industry in Canada have developed in provinces and areas which were abundantly provided with water power resources. This is particularly true of Quebec, Ontario and British Columbia. One has only to recall that Niagara Falls and the St. Lawrence power scheme now being developed, are located in Southern Ontario, and that Quebec has even more favourable water power resources. The B.C. hydro potential, which has attracted an industry of the magnitude of the Aluminum Company of Canada operation at Kitimat, needs no more than a passing reference.

But, it is evident that we are now approaching the economic limits of hydro-electric development in Ontario and that we will, in the forseeable future, do so in the other provinces.

In the past, Ontario has been in a position to consider thermal stations more in the nature of peak load plants to be operated in conjunction with hydro installations, but the fast growing annual increment of its base load power requirements has dictated that the Hydro-Electric Power Commission of Ontario should proceed with the installation for service in 1958 of the first 200,000 kw. steam turbo generator and single reheat steam generator to be installed in Canada.

There are still many undeveloped water power sites in Canada and as new areas and industries are developed these will undoubtedly, if economically justified, provide their quota of power. Nevertheless, in the future, Canada's growing needs for electrical energy will depend on thermal stations.

In the other Canadian provinces where fossilized fuels are available thermal stations of sizes up to 60,000 kw. have been or are being installed, and it is apparent that industrial development in those provinces is dictating a trend toward larger units which will approach or exceed the size discussed here.

At the end of 1950, there were approximately 300 thermal generating stations in Canada capable of developing a total of 642,000 kw. The majority of these stations were located in the east and middle west where fuels are available. During the following four years the power requirements increased considerably and the rate of increase within this period and projected to the year 1958 is shown on Fig. 1.

Although the power generated by thermal stations in Canada is not yet great and represents only approximately 7 per cent of total power generated, the expected increase from 642,000 kw. in 1950 to 2,295,000 kw. in 1958 shows an increase of over 350 per cent during this period.

At December 1954 the thermal stations in this country were capable of developing a total of 1,441,000 kw., and this total is shown graphically by provinces on Fig. 2.

This curve refers specifically to the kilowatts generated in thermal stations, and does not represent the total power load growth that has occurred in these provinces and which has partially or wholly been provided for by additions or expansions of existing hydro plants.

To illustrate further the relative kilowatt load growth forecast for the Canadian thermal power station, Fig. 3 shows the comparison between thermal and hydro generation from 1950 to 1954 and what it is expected to be in 1958.

In relation to total generating capacity thermal generation represented 7.0 per cent in 1950, 11.0 per cent in 1954 and is forecast to be 14.0 per cent in 1958.

In the field of thermal power gen-

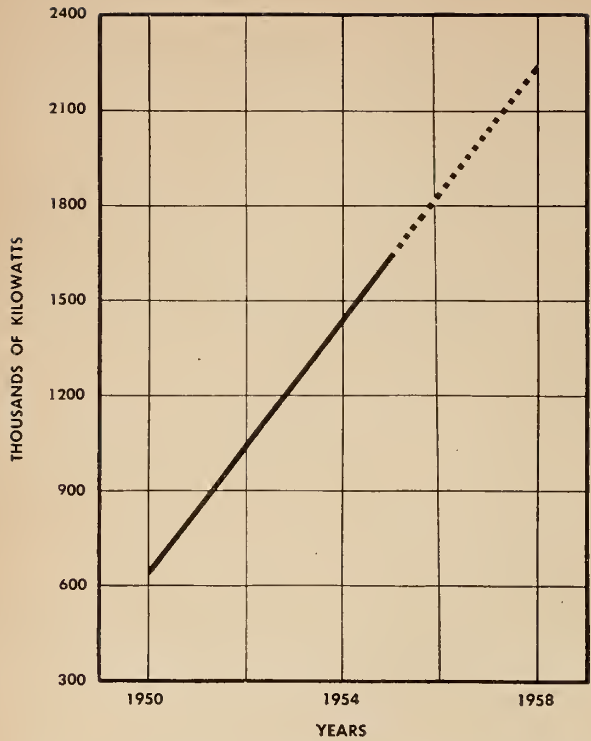


Fig. 1. Available Canadian thermal supply 1950-1958.

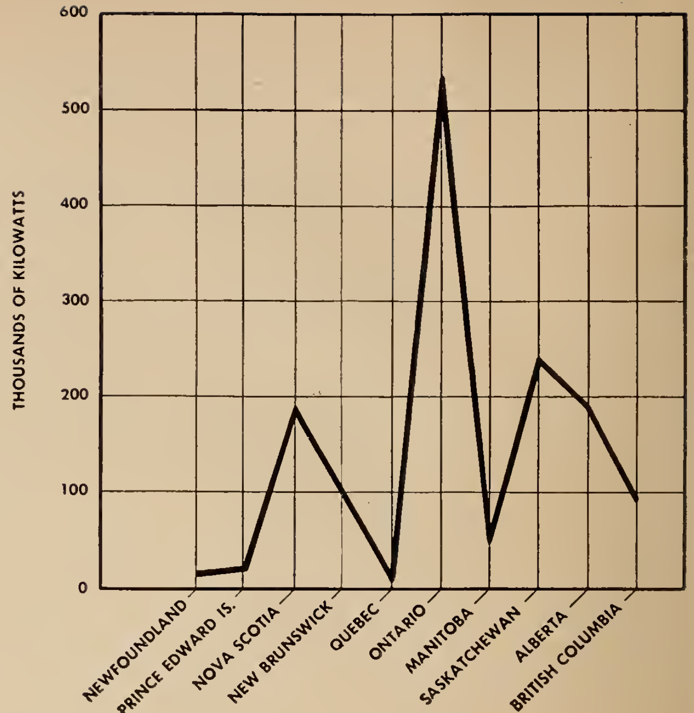


Fig. 2. Available Canadian thermal supply, 1954, by provinces.

eration a thorough knowledge of the characteristics and economics of all available fuels is essential. It is not the intention in this paper to discuss the possibilities of nuclear fuel nor the relative merits of any one fuel, but rather to refer briefly to the better known fossil type fuels abundantly available in certain areas of Canada.

In the Maritimes and along the eastern seaboard are large quantities of bituminous coals which principally serve the generating plants in that area. These medium volatile coals are high in sulphur — sometimes exceeding 4 or 5 per cent — with ash softening temperatures often below 2050 deg. F. so that slag-proof boiler furnaces and convection heating surfaces are required in steam generating units for their successful use. Liquid fuels imported by pipe line and sea-going tankers are also available in the Maritimes.

In the prairie provinces of Manitoba, Saskatchewan, and Alberta, recent discoveries of large quantities of oil and natural gas are being increasingly used for central stations in western Canada. These sources, with existing bituminous and lignite fields, afford the prairie provinces a combination of fuel supply of unlimited scope for future thermal power developments in that area.

The Province of Ontario, because of its proximity to the coal fields of Pennsylvania and West Virginia, uses American bituminous coals widely in steam generation.

British Columbia is abundantly supplied with water power sites, but many of these are so remote from present centres of industry as to make their development uneconomical except for such outstanding enterprises as Kitimat. This province has large deposits of bituminous coal, often of high ash and low heating value, and oil fuel is widely available by sea transport.

The basis of economical steam generation is the efficient liberation and absorption of heat. Boiler and turbine designers have made a tremendous contribution to the power station industry through their continuing search for better and more efficient equipment, which has reduced fuel consumption per kilowatt. Since the first steam-electric plant went into service great changes have taken place in the design of boilers and firing equipment and in pressures and temperatures. We have seen the evolution from boilers of limited capacity fired by underfeed or chain grate stokers, to the modern radiant design units of over one million lb/hr. capacity, with complete furnace cooling and pulverized fuel, gas or oil firing, and up to 300,000 lb/hr. for continuous ash discharge spreader stokers.

In Canada, the design of steam generating units is affected not only by fuel but also by the amount and character of the electrical load, whereas in the United States, for example, electricity is generated chiefly by steam so that most of the generating plants are base loaded. Many of our central generating systems in Canada have a large percentage of their capacity in hydroelectric equipment and less in thermal equipment. Steam plants are, therefore, very often used for peaking in Canada and so must be designed not only for efficient use of fuel, which everywhere is becoming more expensive, but for high and constant steam temperature over a very wide range of loads and for quick and frequent re-start with high steam temperature quickly available to reduce stress on the turbine. These conditions, while by no means unique, are an unusually common problem in Canada.

As the use, and proportion, of steam generation increases in this country, these peaking characteristics may be less essential in design than they are at present but the need for more efficient use of fuel will continue with increasing fuel costs. Here, the advantages of the reheat cycle become very apparent, particularly as this cycle allows a marked reduction in the amount of condenser water required; the supply of this is already a serious problem in large areas of the prairie provinces.

This field of major steam generating units, of advanced pressures and temperature, built for the reheat cycle, for constant temperature over a very wide load range, and for rapid high-temperature start-up, has been entered for the first time in Canada by H.E.P.C. of Ontario in its recently purchased No. 5 unit for the Richard L. Hearn station in Toronto. (Advanced and modern as this new unit is, the ever-pressing need for cheaper power leads us toward supercritical pressure generating units — the first of which in this hemisphere will go in service during this summer at the Philo plant of the Ohio Power Company on the American Gas & Electric System.)

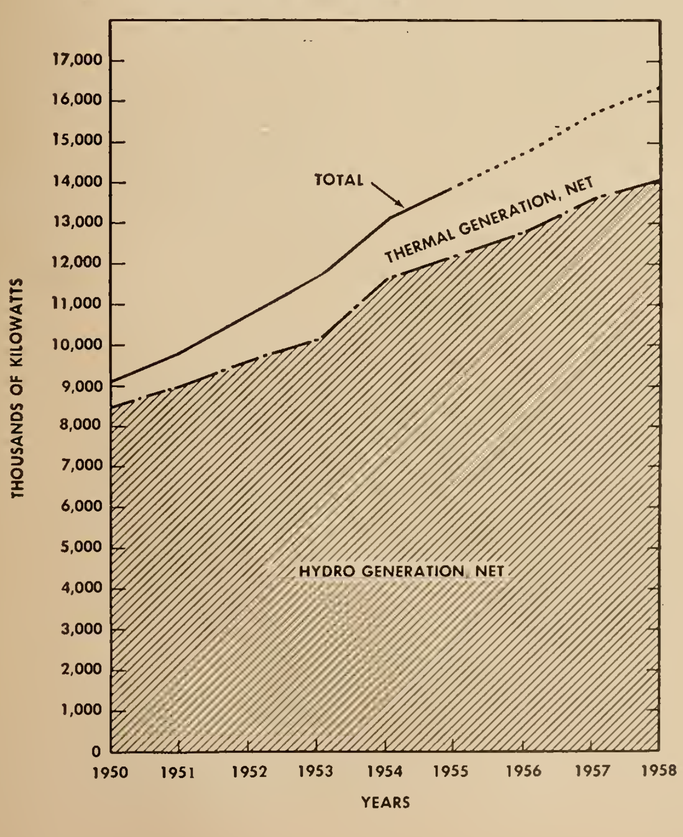
A further advance in the technique of fuel burning has been the development of the cyclone furnace, which is especially suited for low grade, low ash fusion coals, and brings with this outstanding design efficiency and freedom from ash and slag problems. The first installation of this unit in Canada will be at the Nova Scotia Light and Power Corporation in Halifax, which, at present, has two such cyclone fired boilers under construction, each capable of delivering 450,000 pounds of steam per hour at 925 pounds per square inch operating pressure and 915 deg. F. steam temperature.

The principal factors favouring the cyclone furnace were the abundance of low fusion ash coals and the suitability of this method of burning such fuels, demonstrated on similar units.

Figure 4 illustrates this boiler. Incidentally, the first North American supercritical steam generating unit is fired by cyclone furnaces, thus combining two of the most outstanding advances in steam generation.

Though the use of lignite for steam generation throughout western Canada has prevailed for many years, it was not until recently that this fuel became important in pulverized form, although in the last 25 years a couple of small installations had been tried. Perhaps the first major installation in Canada was made at the City of Winnipeg hydro plant in 1950, comprising a fully water cooled, controlled superheat unit of 175,000 pounds of steam per hour capacity, and this successful plant was followed in 1954 by an additional similar unit of 30,000 pounds of steam per hour capacity. This is illustrated in Fig. 5.

Fig. 3. Canadian net generating capability 1950-1958.



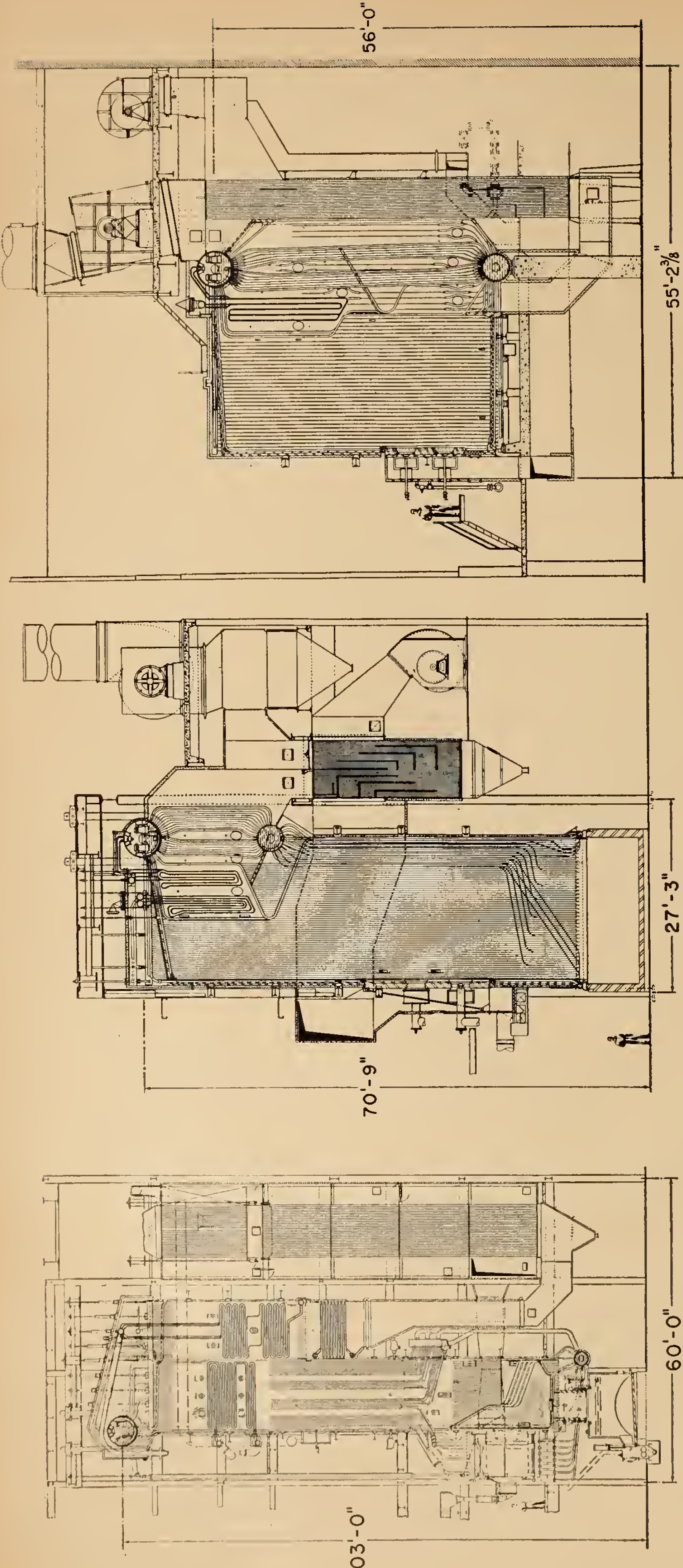
Tests on these units, and the observed results, confirm the efficient and easy utilization of high-moisture lignite in a pulverized direct firing system. Today, units of much larger capacity are in process for other plants due to these satisfactory results.

Figure 6 illustrates another typical Canadian central station boiler; this one recently installed at the generating station of the City of Edmonton, Alberta, to burn natural gas. This unit delivers 330,000 pounds of steam per hour at 415 psig. and 750 deg. F. and is one of 7 somewhat similar units in this station having a total output of nearly 1,500,000 pounds of steam per hour.

Figure 7 shows a unit now approaching completion at the Wabamun plant of Calgary Power Company, near Edmonton, to burn natral gas, or sub-bituminous pulverized coal, or oil, and generate 625,000 lb. steam/hour at 850 psig. and 900 deg. F.; this temperature to be constant from 250,000 lb./hr. output to full capacity.

As already mentioned, broad knowledge of load conditions and of available fuels is essential to the design of steam generating equipment, and this guided the consulting engineer's decision when the Hydro-Electric Power Commission of Ontario some years ago launched their thermal station projects now known as the J. Clark Keith generating station, in Windsor, and the Richard L. Hearn generating station at Toronto. These large boilers, of which there are four in each station, all of similar design, use the direct fired pulverized fuel system and have controlled superheat. The Windsor units are each designed to deliver 650,000 lb. steam per hour at 875 p.s.i., 900 deg. F. total steam temperature; and the Toronto units are each designed to deliver 850,000 lb. steam per hour, at 875 p.s.i. and total temperature of 900 deg. F. Figure 8 illustrates the design of the latter units.

Because of increased power demand, the Commission has found it necessary to expand the Richard L. Hearn station by a further 200,000 kw. and to achieve this has purchased boiler No. 5 which is capable of delivering 1,350,000 lb. steam per hour, at 1900 p.s.i., with steam temperature 1000 deg. F., and a reheat temperature of 1000 deg. F. As this



is the first reheat boiler and by far the largest unit to be installed in Canada, a detailed description may be of interest. (Fig. 9.)

Fuel Considerations[1]

In determining the overall design of the boiler, the first consideration is the fuel. Coal has been selected as the fuel for this unit, after considering market conditions which are constantly changing because of such factors as price fluctuations, seasonal variations in the availability of natural gas, and temporary shortages of coal or fuel oil.

The wide variation in the properties of coal and coal ash are well known, and it is necessary to adapt each boiler design to the particular kinds of coal which will be burned with proper allowance for reasonable deviation from the anticipated coal analysis. Coal with high ash fusion temperatures is inherently suitable for burning in a dry-ash removal hopper bottom furnace. Coal with low ash fusion temperatures requires so much more heat absorbing surface in the furnace for satisfactory dry ash operation that it is more economical to design for slag tap operation with pulverized coal supplied to burners or with crushed coal supplied to a cyclone furnace. The final decision as to furnace design is based on a combination of technical factors, engineering judgment, and at times personal preference.

Design and Functional Requirements

The unit selected for this plant will supply steam for a 200,000 kw. turbo-generator and is to be designed for a capacity of 1,350,000 pounds steam per hour, design pressure of 2200 p.s.i., and operating at 1900 p.s.i. at the superheater outlet, with a temperature of 1000 deg. F. The reheater will be designed for a pressure of 600 p.s.i. at a boiler output of 1,350,000 pounds per hour, the flow through the reheater will be 1,227,000 pounds per hour, with an inlet pressure of 450 p.s.i. and an outlet pressure of 419 p.s.i. The entering steam temperature will be 682 deg. F., and the outlet temperature 1000 deg. F.

The steam temperature at the superheater and the reheater outlet will be held at 1000 deg. F., over an operating range of about 2 to 1.

Fig. 4, 5, 6 (at left, bottom to top of page) Boiler installations at: Nova Scotia Light and Power Corporation, Halifax; City of Winnipeg Hydro-electric System; and City of Edmonton.

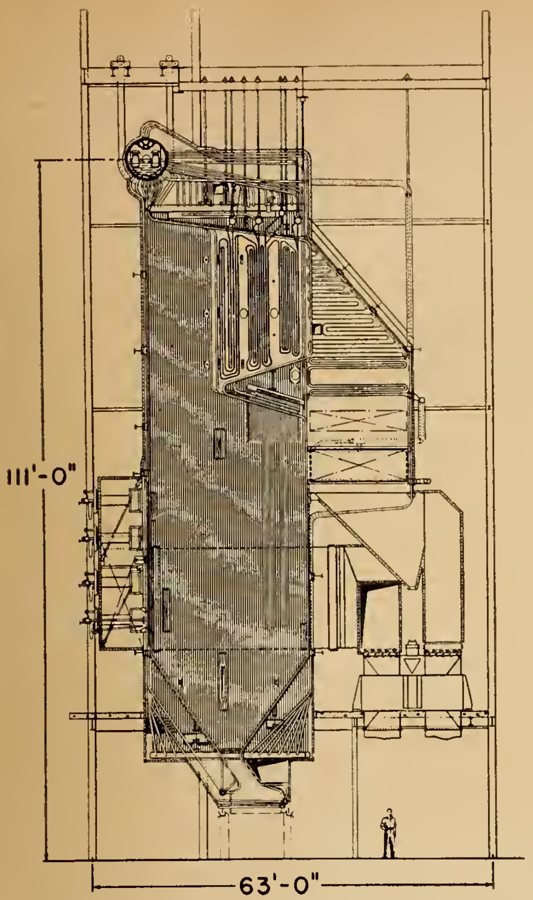


Fig. 7. Calgary Power Co., Lake Wabamun Plant.

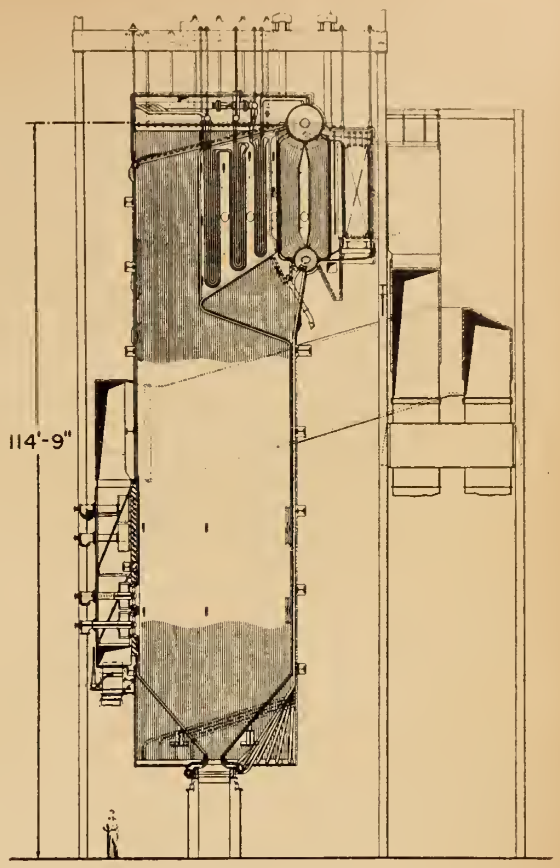


Fig. 8. Richard L. Hearn station, boiler nos. 1 to 4.

Having determined the design and functional requirements of the boiler, the physical size is determined by the total heat absorption. The design of the boiler furnace, where the fuel is burned and the products of combustion are cooled sufficiently to prevent slag difficulties in the convection surfaces, is one of the most important phases of the design, in order to ensure economical steam generation with high availability and low maintenance.

Natural Circulation in Boilers[2]

This boiler is designed for natural circulation, and will have a steam drum equipped with cyclone steam separators which not only makes possible operation with natural circulation at pressures approaching the critical, but has also provided circulation improvements at all pressures, and effected economies in the size and cost of boilers by facilitating the use of smaller drums, furnace division walls, and fewer downcomers.

Boiler circulation, in its elementary form, can be likened to a single U-tube (Fig. 10) connected to an overhead source or reservoir of water. If both legs of the U-tube are filled with water at the same temperature, the system is static. When heat is applied to one leg of the U-tube the temperature of the water in that leg increases and, with sufficient heat, some steam is formed; the weight or density of the water-steam mixture is less than that of the water in the unheated leg and circulation results as the lighter mixture rises and is displaced by a heavier mixture. Flow is from the reservoir, down the cold supply leg, up the heated riser leg, and thus circulation is established.

At low pressures, the difference between the density of the water in the downcomers and that of the water-steam mixture in the riser tubes is appreciable. (Fig. 10.) However, as the operating pressure is increased the steam in the risers is compressed and becomes denser. As a result, the differential density head between the supplies and the risers is reduced and the force available to produce circulation is decreased. In addition, the saturation temperature increases with pressure and, since the water in the downcomers is at, or slightly below, saturation temperature, this causes the density of water in the downcomers to decrease as pressure is increased. This trend to lighter downcomer water density and heavier riser steam density, as saturation temperatures and pressures increase, continues until finally at the critical pressure (3207 p.s.i.) the densities are the same—and it is impossible to obtain natural circulation.

At pressures below the critical the difference between the densities of water and dry steam at the saturation temperature corresponding to a given pressure is the maximum theoretically available for producing circulating head. However, a boiler cannot operate with dry steam in the generating or riser tubes since sufficient water must also pass through these tubes to conduct the heat from the tube walls and carry the steam generated into the steam drum. Thus, the maximum available difference between boiler downcomer and riser densities always is less than that theoretically possible; but the available density differential, even in the pressure range above 2000 p.s.i., is still substantial. Further, if this available density differential can be fully utilized, it is sufficient to produce an adequate and satisfactory circulating force.

Cyclone Steam Separators[2]

In order to ensure steam-free water in the downcomers, it is necessary to provide an efficient method of separation. About 1936 a new design—the cyclone steam separator (Fig. 11)—was developed to remove the steam from the water-steam mixture in the steam drum. These separators are installed in single or double rows in the steam drums, and all steam and circulating water from the risers is collected behind a manifold baffle and then discharged into the cyclones at high velocity; part of the circulating energy is utilized to produce a centrifugal force many times greater than the gravity separating force. This centrifugal action forces the water toward the periphery of the cyclones and the lighter steam flows up the central portion of the cyclone to the top outlet, whence it leaves at a velocity sufficiently low to prevent the pick-up of water; the steam quality is not affected by large variations in the water-steam ratios. Directional vanes at the bottom of the cyclone guide the water into the drum and utilize the velocity energy in the water to overcome the head of water outside the cyclone. This prevents flooding of the cyclones, even when the water level in the steam drum is close to the top of the cyclone, and permits wide variations in water level without affecting circulation or steam quality.

The cyclone steam separator has no moving parts and simply transforms a small portion of the circulating force into the centrifugal force required to separate the steam and water. Thus, there is adequate natural force left, even at very high pressures, to maintain satisfactory circulation without resorting to mechanical devices for assistance.

The first cyclone steam separator installations were so successful that it was decided to build natural circulation boilers for operation at pressures in excess of 2000 p.s.i.

This decision resulted in two industrial installations which have been operating for more than fifteen years, and analyses of their successful performance have provided considerable design data for use in subsequent high-pressure boiler designs. Because of the success of these pioneering developments, the authors' company has installed (or on order at end-April, 1956) 126 boilers designed for pressures above 2000 p.s.i. and averaging more than 1,000,000 lb. steam per hour per unit at rated capacity. Three of the most significant of these are reheat units, designed for a pressure of 2825 p.s.i., which will deliver 2,000,000 lb. steam per hour at 1053 deg. F. and reheat steam to 1053 deg. F. Seven units have a design pressure of 2700 p.s.i.

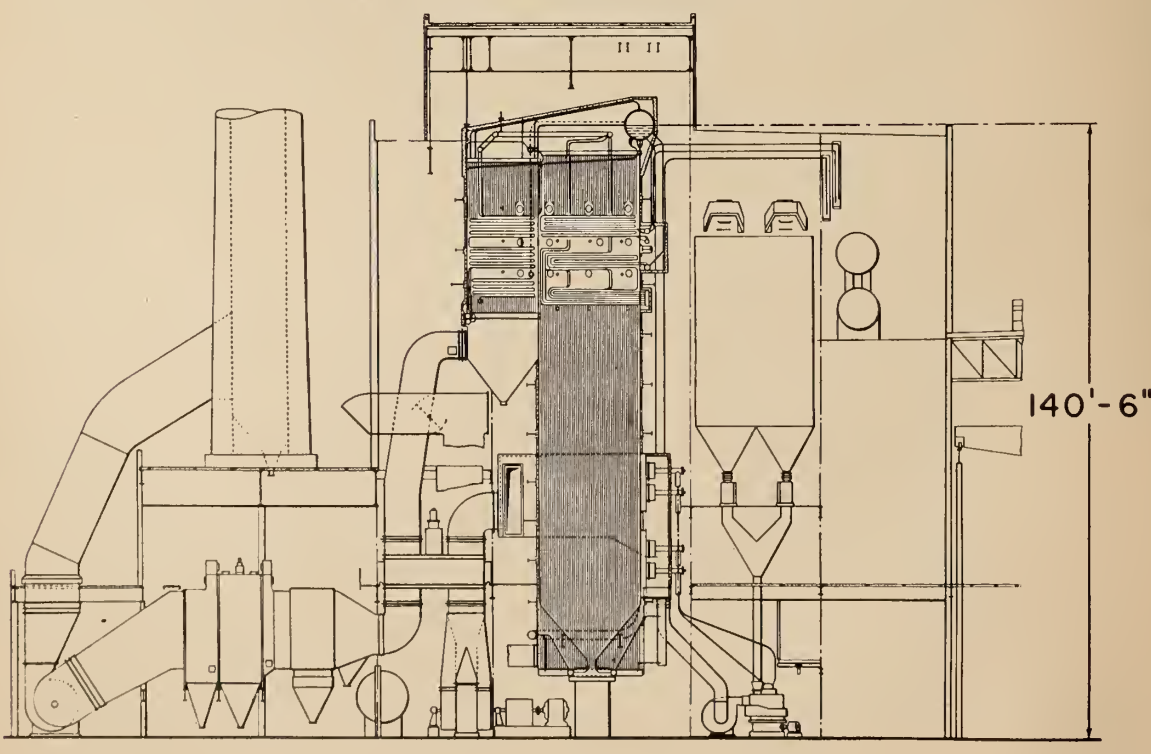
Steam Washers for Silica Removal[3]

One of the problems at present facing the power industry is that of carry-over of vaporous silica, which deposits in turbines. A solution to this problem is a steam washer which removes silica from the steam in the boiler by absorption in wash water such as condensate or feed water.

Manufacturers of power boilers guarantee that solids in the steam will not exceed 1 p.p.m., provided the total solids in the boiler water are held within certain limits, which depend on pressure. However, a boiler may deliver steam well within the guarantee value for total solids, but the turbine may become fouled with silica deposits. Though the problem can be solved with feed water treatment, this solution may not be economically practical.

Model washer tests have resulted in the development of a washer illustrated in Fig. 12. This consists of upper and lower perforated trays, which in addition to their function as part of the washing process, assure proper distribution of steam and water through a small-diameter stainless

Fig. 9. Richard L. Hearn station, boiler no. 5.



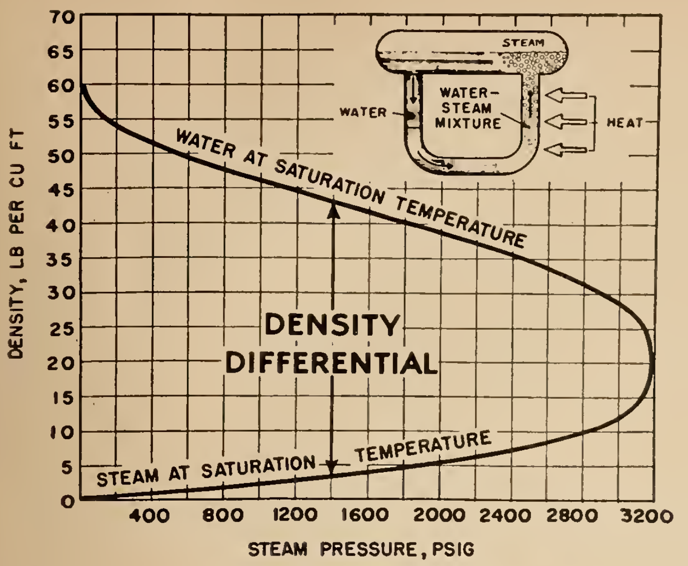


Fig. 10. Effect of pressure on density of steam and water at saturation temperature. Inset, U-tube analogy of natural circulation in boilers.

Fig. 11. Cyclone steam separator.

steel wire-mesh pad several inches thick. Such washers have reduced silica by approximately 90 per cent.

The advantages to be gained by steam washing depend on prevailing conditions, such as silica content of feed water, operating pressure, and the amount of blow-down that can be tolerated. The use of steam washers will permit appreciable reduction in blow-down rates used to control turbine deposits. Tests have indicated that turbine deposits of silica can be controlled by a steam washer at a saving of as much as 80 per cent in the blow-down rate.

A steam washer will be installed in the steam drum of the boiler being discussed, in the space normally occupied by the secondary steam scrubber.

Several high-pressure boilers, now being designed and erected will have steam washers. Figure 13 shows a typical installation. In view of the low initial cost and the large savings offered in turbine maintenance and reduced blow-down with steam washing, it is anticipated that a large percentage of future high-pressure boilers will be so equipped.

Description of Unit

The boiler selected (Fig. 9) is of the radiant type, fired with pulverized coal through circular burners in the front wall at four elevations. The furnace is designed for dry-ash operation, and provided with a hopper bottom for easy ash removal. The secondary superheater and reheater are located in the up-flow convection pass above the furnace. The primary superheater and the economizer are in the down-flow convection pass, below which are two regenerative air-preheaters at the rear of the unit.

The steam drum and all headers for the water walls, superheater, reheater, and economizer will be provided with shop-welded stubs to which all tubes will be strength-welded in the field. This precludes leakage, since the headers will not have gasketed hand-hole fittings. Each header will be provided with expanded and seal-welded nipples which can be removed for inspection.

The furnace width is 49 ft. 6 in. between side wall tubes, and the depth is 24 ft. 0 in. from the front or burner wall tubes to the rear wall tubes. The distance from the bottom of the hopper to the lower row of tubes in the secondary superheater is approximately 82 feet. The over-all height of the unit is about 140 feet, or the height of a 12-storey building.

The boiler is provided with a division wall at the centre of the furnace, extending from the front of the rear furnace wall except for a 2 ft.-0 in. opening at the centre of the division wall. An additional wall section will also be installed at the rear of the furnace midway between the division wall and each side wall. Each wall section will extend into the furnace about 5 feet for the full furnace height.

Supports

The entire unit is top supported by hanger rods attached to headers and tubes with the steam drum supported at each end by laminated straps. All rods and straps will extend to horizontal structural steel at the same level, which permits equal downward expansion of all pressure parts, eliminating the need for expansion joints.

The Boiler Furnace

The boiler furnace serves two primary functions: (a) it provides sufficient volume to facilitate complete combustion; and (b) it introduces ahead of the convection surface sufficient radiant heat absorbing surface to reduce the gas temperature entering the convection surface to a satisfactory level. Generally, for a given fuel and method of firing, this design temperature does not vary appreciably with capacity requirements and, therefore, in similar types of boilers the furnace heat-absorbing surfaces increase proportionately with capacity.

If all the surface is placed in the furnace boundaries, an increase in boiler capacity necessitates an increase in either the furnace width, depth or height; or an increase in combinations of these three dimensions. However, by employing one or more division walls in the furnace, the necessary heat-absorbing surface can be installed while effecting a substantial reduction in boiler size and, consequently, building volume. The use of furnace division walls increases the heat absorbing surface without increasing the furnace volume, and results in a more uniform

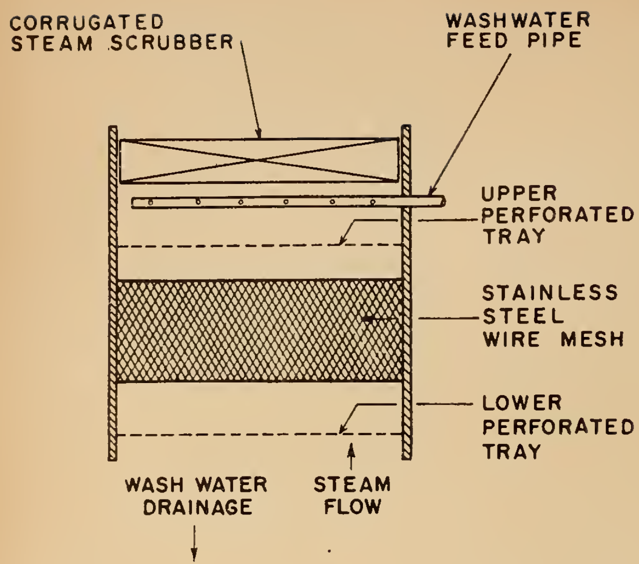


Fig. 12. Wire mesh steam washer.

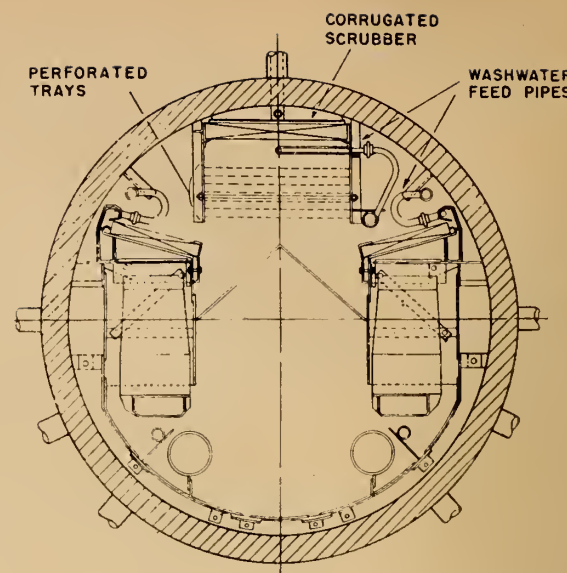


Fig. 13. Combination perforated tray and scrubber washers in high-pressure boilers.

gas temperature entering the convection heat absorbing surfaces (Fig. 14).

In all boiler furnaces there is usually a considerable variation in width of the unit. The tendency is toward temperatures higher than average at the centre of the furnace and well below average at the furnace sides. The differences between the maximum and minimum furnace exit gas temperatures also tend to increase with boiler width. However, the use of a division wall provides, in effect, two smaller-width furnaces and, consequently, reduces the differential. This is most important in the operation of the boiler, since the expected performances are predicted on average furnace exit gas temperatures. Large variations from this average could result in excessive metal temperatures and slagging in those zones of the superheater that receive furnace gases at temperatures well above the average.

Description of Pressure Parts

Steam Drum — The steam drum (weighing some 170 tons) will have a nominal inside diameter of 66 in.; the plate will be 6½ in. thick, and the overall length approximately 62 feet. It will be equipped with cyclone separators and washers as previously described. Four large downcomer pipes (one at each end of the drum, and two along the horizontal axis) will supply water to the various saturated circuits at the lower end of the unit.

Boiler Walls — All furnace and convection heating surfaces are completely enclosed with tangent tube bare walls. No refractory or spaced tubes in the perimeter of the boiler are exposed to hot gases.

The two side walls, the front and rear walls, including the hopper floor, and the division walls will be formed by tangent tubes.

The entire unit will be double cased; the inner casing, of No. 10 gauge plate, will be applied directly against the tangent tubes and seal-welded to minimize air infiltration into the boiler. This casing, being at saturation temperature, moves integrally with the expansion of the pressure parts, so avoiding damage by temperature differentials.

Economizer — The continuous-tube type economizer is located at the outlet end of the down-flow convection pass and will have sufficient capacity to pass all feed water required by the unit without an excessive pressure drop.

All surfaces of economizer, superheater, and reheater tubes and headers are drainable, the headers being provided with drain connections.

Primary Superheater — The primary superheater is at the top of the down-flow convection pass. It has two outlets, each equipped with a spray-type attemperator which is a part of the steam temperature control system.

Secondary Superheater — Steam from the primary superheater passes to the secondary superheater at the lower end of the up-flow convection pass. In this superheater, the lower section will have platens of tubes on 18 in. horizontal centres, and the upper section platens on 9 in. horizontal centres. The outlet tubes end in an outlet header outside the boiler.

Reheater — The reheater is at the top of the up-flow convection section and will be supplied with steam from the high pressure turbine. Steam will enter the header at each end and be distributed through platens of tubes. A spray-type attemperator is located at each of the reheater inlets.

The horizontal spacing of the superheater, reheater, and economizer tubes will minimize the accumulation of slag and ash. Furthermore, cavities provided for the installation of soot blowers will be spaced to facilitate the cleaning of all heating surfaces.

Superheater and Reheater Outlet Connections — Steam at 1000 deg. F. will be taken from the superheater and reheater headers in the vestibule at the front of the boiler to their respective manifold headers, approximately 40 feet from the boiler, by means of multiple tubes. These tubes will have sufficient flexibility to let the outlet headers move vertically 9 inches, for vertical expansion of the main steam pipe to the high and low pressure turbines.

The supply pipes and outlet headers will be supported by spring hangers designed for a predetermined load and motion.

Air Preheater

The unit will be served by two air preheaters, each 24 ft. diameter with 48 in. deep heating elements, the lower or cold air inlet end of which will be made of corrosion-resistant alloy steel. All heating elements will be mounted in baskets which can be readily removed.

These heaters are sized to preheat air from 40 deg. F. to 550 deg. F. at the rated capacity of 1,350,000 lb. steam/hr.

Each heater can be steam-cleaned.

Soot Blowers

The boiler will be provided with soot blowers, using steam as the blowing medium. The superheater, reheater, and economizer will have 8 retractable blowers at each side of the boiler, or a total of 16 blowers spaced between tube banks to provide complete coverage of all surfaces at either side of the tube supports which run vertically through the tube banks.

Twenty-four rotating-type wall blowers will clean the four furnace walls, in the area below the secondary superheater. In the blowing position the nozzle extends into the furnace a short distance beyond the face of the wall tubes. At the end of the blowing cycle the nozzle is retracted from the wall.

The entire soot blowing system is designed for automatic sequential operation and has electric-driven retracting mechanism.

Pulverizers, Feeders and Primary Air Fans

The coal bunker will be at the front of the boiler and directly above the pulverizers. The coal will pass through scales and directly to a feeder which is integral with each pulverizer; rate of feed is automatically controlled by the combustion control system or independently by the operator.

Six type EL-70 pulverizers will each deliver approximately 22,700 lb. coal per hour, at the rated capacity of 1,350,000 lb. steam per hour; 136,000 lb. coal will be burned per hour.

One pulverizer may be operated with its respective burners at a minimum load of 75,000 lb. steam per hour.

Individual motors will drive each pulverizer, primary air fan and coal feeder.

The primary air fan for each pulverizer will be designed to deliver sufficient heated air to the pulverizer to dry and carry the coal to the burners.

Coal Burners and Lighters

There will be 24 circular coal burners in the front wall, 12 on each side of the furnace division wall (6 burners in each of 4 horizontal rows). The burners will be placed to avoid impingement or scouring action on the furnace walls, or the lower row of superheater tubes.

It is possible to increase the steam temperature control range by firing only the upper burners at low loads.

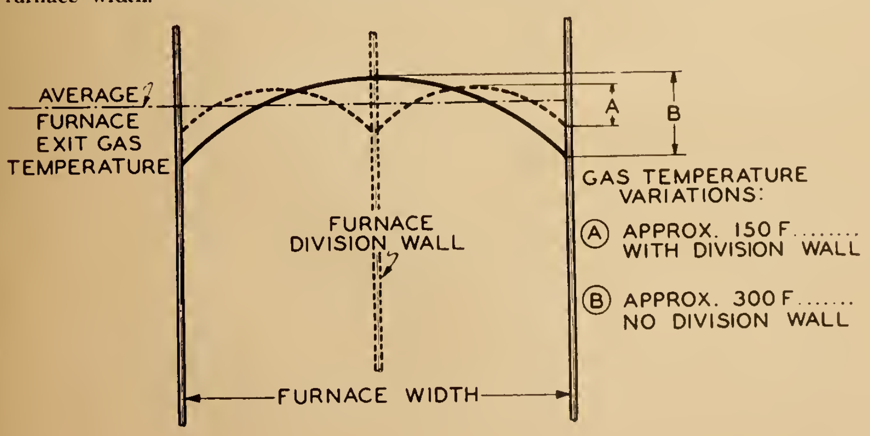
Each pulverizer will serve four burners, two on each side of the furnace division wall. Thus it is possible to operate any number of pulverizers with equal firing on either side of the wall.

The burners are in a secondary air housing, attached to the front wall tubes. This housing will have sufficient cross-section to give equal air distribution to each burner. Heated air from the preheaters will be delivered to each end of the burner housing through two insulated ducts, one at each side of the boiler.

Automatic oil lighting equipment for each burner is interlocked to ensure that the spark is functioning before oil is supplied to the burner.

Remote operating and indicating equipment is provided for each burner to centralize the controls for: operating the oil-fired lighters; retracting or injecting burner impellers; opening and closing air register doors; and operating the valves in the coal-air pipes between the pulverizers and the burners.

Fig. 14. Effect of furnace division wall on variation in gas temperatures across furnace width.



Flue and Duct Arrangement

The gas leaving the economizer enters a plenum compartment (provided with a hopper) from which the gas passes through a flue to the inlet side of the two air preheaters. From the outlet of the air preheaters the gas enters dust collectors through a flue, also provided with a hopper, and leaves through the induced draught fan to the stack.

Manually operated isolating dampers are provided in the gas duct to each air preheater.

Gas for recirculation is taken from the flue between the economizer outlet and the air preheater inlet. This gas passes through a flue to the gas recirculating fan and then to a plenum compartment under the adjacent hopper floor. From this compartment the gas is distributed through the hopper opening and over the furnace wall tubes.

The forced draught fan, at the rear of the unit, has an inlet duct so arranged and dampered that air may be taken from outside or inside the building. The fan discharges air through the two preheaters into ducts, at each side of the boiler, which supply combustion air to the burner windbox at the front of the boiler. A common hot air duct at the rear of the boiler will connect the two ducts at either side, permitting an even distribution of hot air to the burner windbox with one preheater out of service.

All flues and ducts will be supported on hanger rods, and provided with adequate expansion joints.

Steam Temperature Control

When superheated steam is generated for power or process use, it is desirable that the final steam temperature be maintained within specified limits over a range of steam output from the boiler. In power generation this is important in order that maximum turbine efficiency and minimum last stage moisture may be attained without exceeding safe metal temperatures in the superheater, reheater, steam piping or first stages of the turbine, and also to minimize temperature fluctuations.

The addition of a reheater, which is just another superheater, has not complicated operation, but has extended the requirements of steam temperature control. When this control is required over a wide range, as in this case from full to half load, it is necessary to combine control methods.

The automatic controls for draught, combustion, pulverizing equipment, and feedwater flow are conventional and need not be discussed. Since this is the first reheat installation in Canada, the steam temperature control system will be briefly described. There are many installations using this system successfully in the United States.

The basic operating variables influencing steam temperature with this design of boiler, assuming a constant degree of fouling, are:

(1) Superheated and reheated steam temperatures will rise with increased load and fall with decreased load.

(2) Increase in excess air has the effect of shifting heat absorption from the furnace to the convection pass, thereby increasing steam temperatures. Increase in excess air also increases the quantity of gas up the stack, reducing boiler efficiency.

(3) Admission of recirculated flue gas to the ash hopper has an effect on steam temperature similar to excess air, but does not increase the quantity of gas up the stack.

(4) Spray attemperation between the primary superheater outlet and the secondary superheater inlet, and at the reheater inlet, can be used to reduce superheated and reheated steam temperatures respectively.

(5) At fractional loads fuel can be supplied to the upper rows of burners to minimize absorption of heat in the furnace, thereby increasing furnace outlet gas temperature and the temperatures of both superheated and reheated steam, or the lower rows of burners can be fired with the reverse affect.

(6) Reduction in feed water temperature with a feed water heater out of service results in an increase in steam temperature due to the necessity of a higher heat input at a given steam output.

Because of the loss in boiler efficiency, increasing excess air to raise steam temperature is usually uneconomical. Flue gas recirculation and spray attemperation are the basic variables in the automatic steam

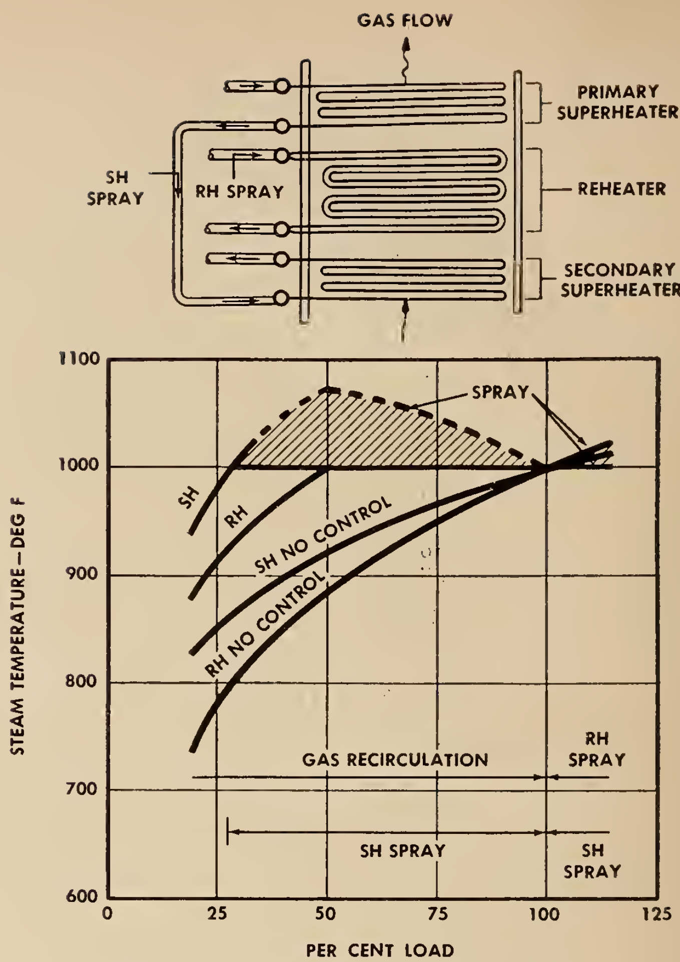


Fig. 15. Steam temperature control diagram.

temperature control system. Results achieved by the steam temperature control system are indicated in Fig. 15 and described below.

Flue gas is withdrawn from a low temperature zone by a fan and is delivered to the lower part of the furnace hopper. The introduction of flue gas at this point has the effect of blanketing the furnace walls, diluting the combustion gas and decreasing the residence time of the combustion gas. This leads to reduced furnace heat absorption and increased convection pass heat absorption, shifting part of the heat absorption from the evaporative to the superheating surface.

The boiler is designed to deliver superheated and reheated steam at a temperature of 1000 deg. F. at full load without flue gas recirculation or attemperation. During periods of overload, when the uncontrolled steam temperatures would rise above 1000 deg. F., spray attemperation is used to maintain the desired steam temperatures. At lower loads, when the uncontrolled steam temperatures would fall below 1000 deg. F., flue gas recirculation is used to increase superheater and reheater absorption and maintain the desired temperatures. If enough gas is recirculated to keep the reheated steam temperature up to 1000 deg. F., the superheater absorption will be excessive and the superheater attemperator must be operated. As load reduction is continued the point of maximum gas recirculation will be reached and further load reduction will cause reheated steam temperature to drop below 1000 deg. F. while superheat attemperation is reduced. Further load reduction will permit less and less superheat attemperation to be used, until zero superheat attemperation is reached, and then the superheated steam temperature also will fall below 1000 deg. F.

The steam temperature control equipment is shown schematically in Fig. 16. Steam flow, which is an index of boiler heat output, serves as the anticipating element for regulating the gas recirculating fans. The product (gas flow x gas temperature) in the superheater region, which is an index of heat flow over the superheater, provides an impulse which depends upon the actual amount of recirculation. Final adjustment of gas recirculation is made by an impulse from the lower of the two reheater outlet steam temperatures through the selective relay. The recirculating fan is kept running at all times, the quantity of gas recirculated being controlled by hydraulic coupling drive and dampers. Solenoids connected to the recirculating fan motor circuit serve to close the recirculating fan shut-off dampers and to open the damper which admits cooling air to the recirculating system when the recirculating fans are out of service.

The Babcock & Wilcox Company have developed the spray type attemperator (Fig. 17), for reducing and controlling the temperature of a superheated vapour or liquid. This consists of a spray nozzle, in the superheated steam line, through which a spray of low-solids-concentration water is injected into the steam which it cools by evaporation. A thermal sleeve protects the steam piping from quenching stresses.

That part of the total steam output which is supplied as spray water does not pass through the economizer nor through the superheater section preceding the attemperator, a fact which is important in design calculation of performance and superheater tube temperatures. Attemperator water is usually taken from the boiler feed line at a point ahead of the feed control valves.

Spray attemperation in the reheater, required only during overload, is regulated solely by reheater outlet steam temperature. Spray attemperation in the superheater is governed by an anticipating impulse from the product of gas flow rate x gas temperature, and by an impulse from attemperator outlet steam temperature which depends upon the actual amount of attemperation. Final adjustment of superheater attemperation is made by impulses from secondary superheater outlet steam temperatures.

Quick Starting

In recent years the load characteristics of some utility systems have made it economically desirable to remove large units from service after the evening peak, hold them idle overnight (or over weekend), and return them to service in the morning, picking up load at a rapid rate.

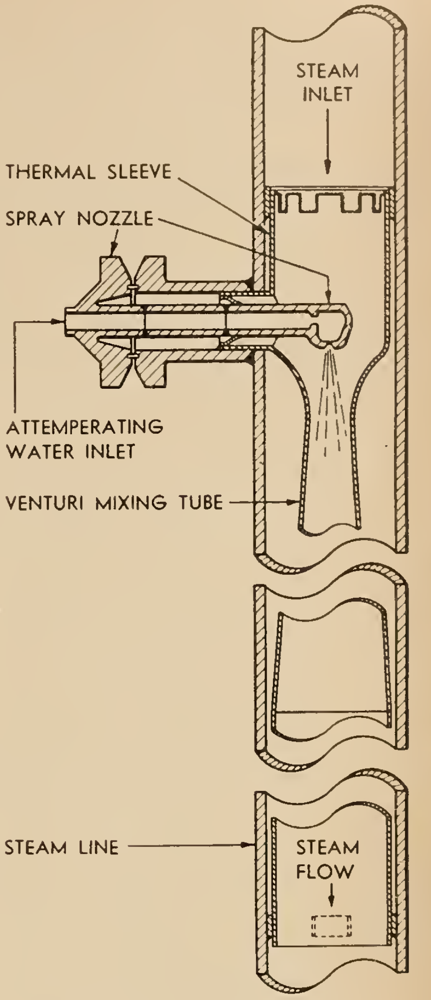
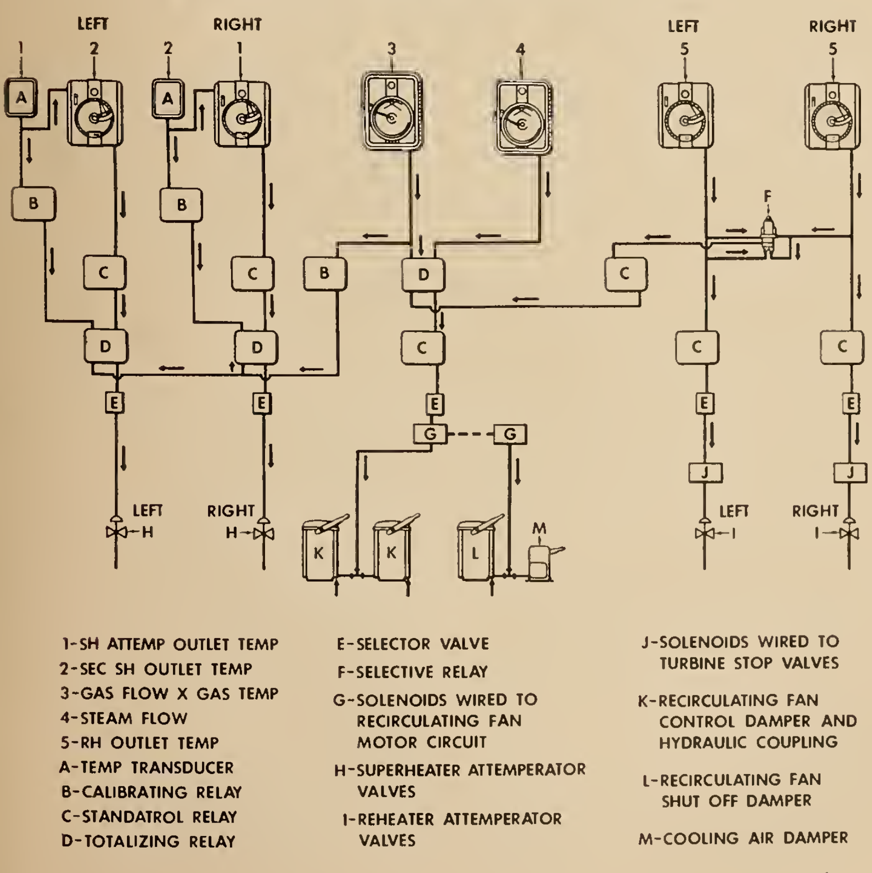


Fig. 17. Spray type attemperator.

Fig. 16. Schematic steam temperature control diagram.



This practice is known as quick starting. Much pioneer work in this phase of operation has been done by Consolidated Edison Company of New York.[4,5,6]

When a boiler is brought from no load and low pressure to full load and full pressure in a short time precautions must be taken to avoid the following difficulties:

(1) Excessive thermal stresses resulting from extreme temperature differentials in the drum metal during the transient period.

(2) Excessive differential expansion in the remainder of the unit because of extreme temperature inequalities.

(3) Overheating the superheater and reheater metals during the no-flow and low-flow periods.

(4) Damaging the turbine by admitting steam at temperatures too different from that of the turbine metal parts at the steam admission end.

Firing a boiler when it is completely cold after a prolonged outage causes circulation of water within the circuits, and therefore heats the lower half of the drum with which the water comes in contact. The part of the drum above the water line receives very little heat from the water, but may receive heat from steam bubbles released in the drum, or from steam generated by vaporization of condensate in the superheater. The top and bottom of the drum therefore change temperature at diferent rates. When saturation pressure of the water reaches atmospheric pressure, the air within the drum is rapidly purged from the drum through the vent and replaced by saturated steam, which condenses on the metal of the top part of the drum. Since condensing steam provides very rapid heat transfer, the inside metal of the top part of the drum quickly approaches saturation temperature. During the subsequent pressure-raising period the inside surface of the drum, both top and bottom, rises in temperature almost as fast as saturation temperature, while the outside temperature of the drum rises more slowly as dictated by the laws of unsteady state heat conduction. Temperature differences in the drum metal induce two sorts of stresses: inequalities between top and bottom of the drum produce axial tension and compression stresses which are partially relieved by drum bowing; inequalities between inside and outside of the drum shell produce circumferential stresses. Heat input to the furnace and rate of saturation temperature rise may have to be restricted to keep these stresses within acceptable limits. However, when starting a 2200 p.s.i. boiler at an initial pressure between 500 p.s.i. and 1500 p.s.i. following a relatively short out-of-service period, the drum is already hot (467 to 545 deg. F.) so that rates of saturation temperature change, as limited by other considerations, will not cause excessive stresses in the drum metal.

Differential expansion in other parts of the boiler is rarely a problem, since boiler designers incorporate sufficient flexibility to avoid this difficulty. By inducing more vigorous circulation as a consequence of the higher input, quick starting produces a more uniform temperature distribution throughout the boiler, and therefore smaller differential expansion stresses, than a conventional slow start.

Protection of superheater and reheater tubes during start up requires:

(1) that the maximum gas temperature entering the superheater and reheater sections be restricted to approximately 950 deg. F. during period of no steam flow;

(2) that heat input to these tubes be limited to acceptable values during periods of low steam flow, particularly at reduced pressures where steam film conductances are less than normal.

During start-up temporary thermocouples should be positioned in the gas stream ahead of the superheater to monitor the gas temperature entering the superheater. With a nondrainable superheater, thermocouples installed on the outlets of the tubes are required to indicate whether or not the tubes are completely clear of condensate before the boiler goes on the line. In some cases the rate of firing must be restricted for several hours until the last tube has cleared. With a drainable superheater, such as is being furnished on this boiler, it will take only a few minutes to drain the headers of condensate, and it will not be necessary to wait for loops to clear.

Thermocouples installed on the tubes at the steam outlet header to indicate steam temperatures from the individual tubes are still desirable, however, to assure the safety of superheater and reheater tubes during operation. If steam pressure is held steady, or is increased only slowly during initial loading of the boiler, superheater and reheater tubes will operate at safe metal temperatures provided the indicated unbalanced steam temperatures do not exceed design limits. However, overfiring to raise pressure rapidly can result in overheating of the tube metals even if steam temperatures from individual tubes are within proper limits, since under these circumstances a major fraction of the heat absorbed by the water-cooled surfaces is being used to increase the pressure instead of generating steam which would normally flow through and cool the superheater and reheater tubes. A prudently restricted rate of steam pressure rise is not prejudical to fast starting, since it is satisfactory, and actually advantageous, to admit steam initially to the turbine at reduced pressure.

When a turbine is taken off the line it will cool gradually. Elston's data[7] show that during an eight-hour out-of-service period the steam chest of a 1000 deg. F. machine may cool to 600 deg. F. and the reheat admission space to 710 deg. F. Turbine manufacturers usually wish to have steam temperature 100 deg. F. above steam chest temperature during restarting after a cooling off period. To provide the desired temperature, which will vary for different operating and out-of-service periods, it is necessary to have a flexible steam temperature control system such as that supplied for this unit. The actual operating procedures which will be desirable to give the required steam temperatures can be determined only by experience.

Quick Pick-Up

Because suitable water power sites are usually remote from electrical load centres, hydro-electric systems tend to have long transmission lines which are vulnerable to interruptions. Steam plants operating near the load centres in parallel with hydro-electric units are therefore designed to accept sudden large load increases. Special features can be incorporated in the boiler, its auxiliaries, and its controls to meet rapid load pick-up needs [8, 9, 10, 11, 12].

When the steam demand on a boiler is suddenly increased there is a short period of rapid pressure reduction before the firing equipment can again supply heat to the steam generating unit as rapidly as it is removed. The pressure reduction has two effects:

(1) the volume of existing steam bubbles increases;

(2) some of the water in the circulating system flashes into steam.

The resulting increase in volume of the steam-water mixture causes the water level in the drum to rise. A large drum can therefore be used to minimize water level surge. To keep the water level variation within permissible operating limits, a long gauge glass should be supplied and water level controls adjusted to carry a low level at low loads and a high level at high loads. A three-element feedwater regulator can easily be so adjusted.

If fast load fluctuations are to be properly handled, firing equipment must have rapid response characteristics. On this unit the air-swept ball-bearing type pulverizers, which respond very rapidly, are supplemented by remote operation of lighters, burners, and coal valves so that, if necessary, additional burners can be quickly put into service. Firing and draughting equipment must be generously sized so that the extra heat

(*Continued on page 26*)

Co-operative Research in the British Electrical Industry

J. Miedzinski

Development Engineer, Department of National Defence, Navy, Ottawa

Read at the 70th Annual General and Professional Meeting of the Engineering Institute of Canada, Montreal, May, 1956

Co-operative research in Great Britain is carried out through several organizations, but specialized research associations are responsible for most of the work. There are forty such associations, half of them with over thirty years' experience. They are maintained by industry, with the help of Government grants. The electrical industry reorganized its earlier research committees into the form of the British Electrical and Allied Industries Research Association (E.R.A.) in 1920. The E.R.A. research program is arranged to avoid projects which could be carried out economically by the private research of her members. It is therefore mainly concerned with initial examination of new concepts on the one hand, with marginal improvements of established techniques on the other, and with testing, standardization, co-ordination of effort, etc. Examples given in the paper illustrate E.R.A.'s work on the characteristics of cables and overhead lines, study and abatement of radio interference (including a fundamental investigation of electro-magnetic shielding), and the development and operation of a large analogue computer (network analyser).

THE GROWTH OF the co-operative research movement within British industry dates from the 1914-1918 war when the need for applied research became apparent. Few industrial firms were large enough to run an effective research department and the Universities were fully occupied with fundamental research. It was recognized that much of the applied research was of interest to many firms in the same industry and so research committees were formed to ensure that the scarce research facilities were not wasted by duplication of efforts. The Government decided to stimulate this industrial co-operation by grants so that an industry could set up a research association, under its own control, to deal with common problems. Twenty such associations were formed from 1918 to 1926 and the number is now forty. The industries covered range from purely craft and processing, such as the ceramic, baking, hat and felt making industries, to the highly scientific, such as the shipbuilding, iron and steel, steam turbine manufacturing, and electrical industry.

Those of particular interest to engineers are:

- Cast Iron Research Association
- Coke Research Association
- Iron and Steel Research Association
- Non-Ferrous Metals Research Association
- Steel Castings Research Association
- Coal Utilisation Research Association
- Hydromechanics Research Association
- Internal Combustion Engine Research Association
- Electrical Research Association
- Parsons and Marine Engineering Turbine Research and Development Association
- Motor Industry Research Association
- Production Engineering Research Association
- Shipbuilding Research Association
- Welding Research Association
- Scientific Instrument Research Association
- Coil Spring Federation Research Organisation.

These sixteen associations between them have a present income of some 2.5 million pounds, of which roughly four-fifths is subscribed by the members of the various industries and the remaining one-fifth consists of grant from the Government. The conditions of grant are usually so arranged that, though considerable support is given to a newly-formed research association, there is an incentive to increase the ratio of industrial income to that derived from the Government. The size of the research associations listed above varies greatly. The smallest has an income of about £15,000, the largest £500,000. Each maintains a central co-ordinating committee structure and central laboratories, and each to some extent supports fundamental research in the Universities.

In addition, the engineering industry in Britain has recourse to Government research establishments which, although not directly associated with any particular industry, maintain programs continually kept in step with the trends of development in the industries falling within their scope. Such Government laboratories are —

- Building Research Station
- Fuel Research Station
- Hydraulics Research Station
- Mechanical Engineering Research Laboratory
- National Physical Laboratory
- Radio Research Board
- Road Research Station
- Forest Products Research Laboratories

The British Electrical and Allied Industries Research Association, commonly known as the Electrical Research Association or E.R.A., serves primarily the electrical industry. The latter, by virtue of its very widespread interests, contributes also to many other research associations. Similarly the E.R.A. derives support from many sources which have only a partial, and sometimes minor, direct interest in electrical matters, e.g., the coal and transport industries, paper manufacturers, and oil refineries.

Development and Structure of E.R.A.

The conception of the E.R.A. dates back to 1913 when the Research Committee of the Institution of Electrical Engineers was established to organize research on the heating of buried cables, on mica, porcelain, and insulating oils. It was followed in 1915 by the Research Committee of the British Electrical and Allied Manufacturers Association which studied composite insulants, fibrous materials and ebonite, condenser corrosion and turbines. These two bodies were fused in 1917 as the Electrical Research Committee, the direct predecessor of the E.R.A. The latter was incorporated in 1920, with Government support through the Department of Scientific and Industrial Research under the scheme to which reference has already been made. To the scope of its predecessor was added work on basic principles of invention exemplified at the outset by the circuit-breaker researches.

The broad aim of the E.R.A. is to promote research in the general interest for the progress and development of the electrical and allied industries. The type of research concerned is that for which the industrial reward would not justify individual action and must therefore be pursued collectively, together with that which, in any case, must be applied collectively. Within these limits the particular objects include:

(1) conduct of fundamental and empirical researches leading to better understanding of underlying principles affecting design, manufacture and use;

(2) preparation of surveys of the state of knowledge to assist members in ascertaining useful avenues for new developments;

(3) development of new, improved and cheaper apparatus and materials;

(4) investigation of factors affecting the life, reliability, safety, efficiency and economical utilization of equipment and materials;

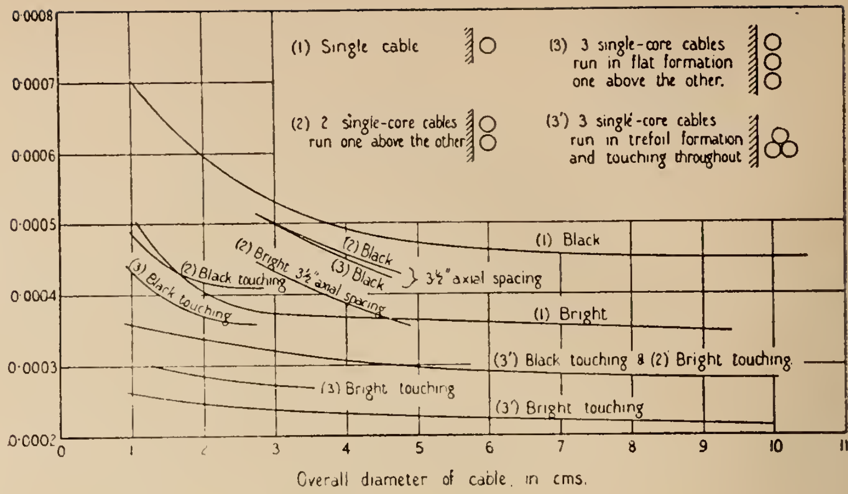


Fig. 1. Curves showing the constant of heat emission h for both black and bright surfaces.

(5) development of methods of testing; and

(6) experimental establishment of common bases of evidence upon which standard specifications, rules and regulations can be formulated.

The membership of the E.R.A. is open to supply undertakings, manufacturers, consultants, and nationalized or other semi-official bodies. It now includes nearly all the British electrical industry, with representatives for the majority of the members of the Commonwealth. Each of the supporting organizations is represented on the council. The council establishes sectional committees, each of which deals with a major field of work. The function of a sectional committee, which consists of eminent persons representative of all the interests concerned in its field, is mainly advisory. It sets up subcommittees of experts who, under its supervision, give more detail consideration to individual research projects. Sub-committee members are chosen from member organizations and firms, or they may be independent experts from Universities, Ministries, Government departments and laboratories or other research associations.

It can be seen that at both administrative and executive levels the organization is such as to ensure truly co-operative effort by assembling together on neutral ground scientific and industrial experts representing all the interests involved.

The co-operative principle extends also to the placing of research programs. The E.R.A. is in close contact through its committees and otherwise with the Universities, with the research departments of its members, and with Government and other research laboratories. Therefore, where it is economical to make use of existing facilities in such laboratories for the conduct of a particular research, this can often be arranged. Indeed, in the early stages of the E.R.A.'s existence the majority of its work was done extra-murally. In 1955, however, only 30 per cent of the total research expenditure was for extra-mural programs.

Nature of E.R.A. Researches

The structure is such that the range of subjects covered is wide. Those fields tend to be excluded in which there is the likelihood of substantial and rapid advances of commercial importance, since these naturally tend to be adequately covered in the laboratories of member firms. Co-operative research has its best application either at an earlier or later stage, as when a conception requires proper examination and basic research before handing over to industry; when marginal improvements in utilization of long established material or processes can be secured either by a short or a continuous programme of research; or when characteristics of commonly used plant or materials require determination.

Some examples in each category may be cited. Over the past few years, co-operative research has sponsored an investigation into the hydrogen-oxygen fuel cell, in which electricity is produced directly from the combination of oxygen and hydrogen. This was taken up when it was, at best, capable of demonstration as a scientific curiosity, on a very small scale. It has been brought to the stage when application on an industrially useful scale can be demonstrated. Commercial evaluation is now in progress but whether or not the matter is pursued, co-operative research will have fulfilled its proper function in providing the information on which such a decision can properly be taken. Similarly co-operative research has, since the war, continuously carried on a program of research on high voltage transmission by direct current, so that British industry has at all times been in a position to proceed, if the economic situation so warranted, with the commercial development of the necessary plant.

The best example in the second category is the study of insulation. This was early recognized as a proper and fruitful subject for study, and major programs have been maintained for over thirty years. Academic physicists working on programs supported by E.R.A. have made important contributions to the theory of dielectrics as, for example, in the classical work of Frohlich, and have also taken a leading part in the discovery of electronic intrinsic breakdown and in much of the work carried out since. A quantitative theory of ionic discharges in insulation, due in considerable measure to the E.R.A., has proved the way to most insulation failures in high voltage equipment. New methods for the detection of, and increasing resistance to, discharges have been developed. The theory of the electro-chemical breakdown of low voltage insulation has been developed and one application, the addition of protective substances, can increase life 20 times under certain conditions. The applied research has led to 12 British Standards, but more important is the influence of both fundamental and applied research on the better selection of materials, the introduction of new and the improvement of early materials.

The third category is exemplified by the E.R.A.'s study of the properties of steam. This may appear a peculiar subject of study for co-operative research in the electrical industry. It is, however, steam plant for the electrical industry which is always in the van as concerns use of the highest possible steam temperatures and pressures. Thus in 1939, because electricity supply required higher temperatures and pressures in turbines, the E.R.A. published the Callendar and Egerton steam tables, up to 1,000 degrees F., and this is still the limit of international agreement. Reliable tables up to 1,300° F. and 6,000 lb./sq. in. are now urgently needed and the E.R.A. has constructed extra-murally a unique plant for the accurate measurement of the properties of steam, in which work has started on investigating higher steam conditions. This work on the properties of steam is accompanied by a study of the properties of steels for pipework.

The researches on switchgear, the first undertaken by the Association in its own laboratories, had quite remarkable results. They were the first sustained and systematic investigation of this kind in the world, and appear to have set the pattern for all such investigations elsewhere. In the late twenties they resulted in the invention and patenting of the air-blast breaker, the baffle breaker, and the differential piston breaker, which were rapidly taken up by industry and constitute the great majority of all high voltage breakers built within the past twenty years.

It is not possible to deal here with all the E.R.A. activities; attention will therefore be confined to a few fields in which achievements have been specially notable, which are thought to be of particular interest to Canada, or with which the author has been directly concerned.

Cables and Overhead Lines

In what are essentially common problems the aim is to secure the best uniform practice. An example is the research on ratings for paper-insulated cables, which initially was inherited from one of the E.R.A.s predecessors. This first involved fixing permissible operating temperatures having regard both to deterioration of insulation and to strains imposed on the cable and its joints by thermo-mechanical forces. These had to be associated with appropriate ambient conditions, and the thermal constants of the cable materials and of the surrounding medium determined to enable the heat dissipation to be calculated.

Experimental work has included determination of: thermal resistivities of cable materials, skin and proximity effects, sheath and armour losses, thermal resistivity of the soil and investigation of the factors which affect it, thermal resistivity of duct material and thermal resistance of

Table I. Maximum Permissible Conductor Temperatures for Paper-Insulated Cables

Voltage* and Type	Laid direct (15°C. ground temperature) and in air (25°C. ambient)					In ducts (15°C. ground temperature)				
	Lead-sheathed				Aluminum Sheathed	Lead-sheathed				Aluminum sheathed
	Armoured		Un-armoured		Armoured or un-Armoured	Armour-ed		Un-armour-ed		Armour-ed or un-armour-ed
	1941 °C.	1955 °C.	1941 °C.	1955 °C.	1955 °C.	1941 °C.	1955 °C.	1941 °C.	1955 °C.	1955 °C.
1.1 kv.										
Single-core			70	80	80	..	.	50	60	80
Twin and multi-core (belted)	70	80	70	80	80	70	80	50	60	80
3.3 and 6.6 kv.										
Single-core	.	..	70	80	80	..	.	50	60	80
3-core (belted)	70	80	70	80	80	70	80	50	60	80
11 kv.										
Single-core	..	.	70	70	70	..	..	50	50	70
3-core (belted)	65	65	65	65	65	65	65	50	50	65
3-core (screened or SL)	70	70	70	70	70	70	70	50	50	70
22 kv.										
Single-core	..	..	65	65	65	.	.	50	50	65
3-core (belted)	55	55	55	55	.	55	55	50	50	..
3-core (screened, SL, or SA)	65	65	65	65	65	65	65	50	50	65
33 kv. (all screened)										
Single-core	.		.	65	.				50	
3-core (SL or other)	..	65	.	65	.	.	65	.	50	..

* 1941 figures are for voltage of 1 kv., 3 and 6 kv., 10 kv., and 20kv.

multiway duct structures with varying degrees of occupation, overall dissipation constants for typical configuration, and modes of installation of cable circuits in air. The latter are illustrated in Fig. 1. These have enabled ratings to be computed for known conditions, but in many cases check tests were made.

The conductor and ambient temperatures adopted in the first comprehensive rating tables published in 1941 together with revised values recently agreed for the current edition [1] are given in Table I. The soil resistivity [2] for which ratings for cables laid direct and in ducts were tabulated in 1941 was 120° C. cm./W; in 1955 tables were included for both 90 and 120° C. cm./W.

The first standard ratings issued were estimated to save the supply industry many millions of pounds by improving the utilization of cable systems in existence at the time and by reducing expenditure on subsequent extensions. The later relaxations for modern cables have permitted increased ratings, shown for typical cases in Table II and these, together with full use of cyclic rating factors which can now be computed for practical load curves [3] will result in further substantial economies.

In addition to the work on continuous and cyclic ratings extensive investigations have been carried out on the effects of short circuits on cables. [4]

Similar work has been done in connection with installations for buildings. Ratings and corresponding voltage drop data for cables with paper, rubber or plastic insulation, and bare copper busbar systems for all the common modes of installation have been determined and incorporated in the I.E.E. wiring regulations. [5]

As regards bare overhead line conductors no generally accepted limit for operating temperatures has been agreed. Ratings have, however, been determined for a range of temperatures up to those at which long term annealing of the materials concerned is likely to occur. Data on forced convection related to conductors of the size and type considered were lacking for weak cross winds, up to 1 mile per hour, which are likely to occur on even a calm day. Laboratory tests to establish the effect of such winds were made and typical results are given in Fig. 2. The investigation has been fully reported [6] and the ratings incorporated in a book [7] which also deals comprehensively with the theoretical considerations that decide the electrical characteristics of overhead power lines and the practical estimation and application of those characteristics. In this book the practical data are presented as tables and alignment charts from which the main electrical characteristics of a line can be easily and quickly obtained with sufficient accuracy for transmission engineering purposes.

Radio Interference

In 1930 an *ad hoc* conference of interested international organizations took place in Paris to decide how the subject of radio interference should be dealt with internationally. Arising from this the C.I.S.P.R. (Comité International Spécial des Perturbations Radioélectriques) was formed under the aegis of the I.E.C. and the U.I.R. and its first meeting was held in 1934. In the U.K. a committee of the Institution of Electrical Engineers met in 1933 to discuss radio interference from the national viewpoint. The E.R.A. may be said to have been aotively associated with the problem from that date. In co-operation with the G.P.O., the B.B.C., and the electrical and radio manufacturers, definitions were sought for the tolerable degree of interference, the standard of transmission and also of receiver to be protected, and for the means of measuring and assessing the interfering signals. In addition, examination was made of the various methods available for the correction of interfering appliances and installations, and how these methods could be used, bearing in mind the need for compliance with the codes of safety and good engineering practice of the Home Office, Ministry of Transport, Institution of Electrical Engineers, Lloyds, and other bodies.

Considerable advances were made during the pre-war years and the state of the art by 1938 is admirably summarized in the paper by A. J. Gill and S. Whitehead which was read before the wireless section of the Institution in April of that year.

By 1939 a number of British Standards had been prepared, notably those dealing with the characteristics of measuring equipment; the permissible limits of radio interference from appliances (broadcast bands), motor vehicles (television band I), and trolley buses (broadcast band); the quality of components to be used for suppression purposes. A number of standards were also in course of preparation, including one related to the anti-interference characteristics of broadcast receiving installations and one concerned with industrial and medical radio frequency equipment.

During the war years full use was made of the Association's knowledge and experience by the Ministry of Supply and the Admiralty. The high standard of communications achieved by the land and coastal forces may be said to be due largely to the E.R.A. work on the suppression of radio interference in armoured fighting vehicles and coastal assault craft.

After the war the general work on radio interference was resumed. With increased interest in services at the higher frequencies the pre-war standards became out-dated and most have now been completely revised. In addition new standards and codes of practice have been produced and in all to date some seven standards and four codes of practice have been issued, based largely on

Table II. Comparative Ratings for Paper-Insulated Cables, 1941-1955

*Voltage and Type	Size	Laid direct 1941	Laid direct 1955	In ducts 1941	In ducts 1955	In air 1941	In air 1955
1.1 kv.							
3 single-core unarmoured served	(0.04	142	150	107	125	136	155
	(0.5	564	610	401	465	665	750
4-core armoured served	(0.04	128	140	101	115	113	125
	(0.5	517	570	400	475	537	610
3.3 kv.							
3 single-core unarmoured served	(0.04	135	140	109	125	144	160
	(0.5	522	560	397	465	681	760
3-core armoured served	(0.04	125	135	102	115	118	130
	(0.5	492	530	406	475	552	620

° 1941 ratings are for cables up to 1 kv. and for 3 kv.

Note:

1. Three single-core cables are laid in trefoil with servings touching when direct in ground or in air, or drawn singly into trefoil ducts.
2. Ratings laid direct and in ducts assume a soil of 120°C. cm/W thermal resistivity.

the work of the Association. Further, the Association in the person of the director, has assisted on the advisory committees set up by the I.E.E. for the purpose of advising the Postmaster General on legislation in respect of interference caused by the ignition systems of internal combustion engines, by refrigerators, and by small electric motors.

In the international field the E.R.A. has been closely connected with the work of the C.I.S.P.R. since its inception, the director having been for several years chairman of the committee. In this sphere agreement may now be said to have been reached on the methods of measurements to be used up to 25 Mc./s. or 30 Mc./s. and the ground work for measurement at higher frequencies well prepared. Some measure of agreement has also been obtained as to what may be regarded as a tolerable limit for radio interference in the broadcast bands.

From the wide range of subjects studied it is difficult to select representative examples. One which may be of particular interest is concerned with measuring equipment. The measuring equipment used in the U.K. and on the Continent differs significantly from that used on this side of the Atlantic. Though basically a quasi-crest type of valve voltmeter is used at the output of a constant bandwidth receiver, as in North America, the general conception of the function of measuring equipment in Europe differs from that in America and Canada.

All who have had experience in the measurement of radio interference are aware of the great variety of signal which must be measured and the large and rapid variations which take place in the amplitude of any one type of interference. For these reasons the quasi-crest type of meter found universal adoption. In Canada and the U.S.A. the variability of the signals to be measured was offset by the wide-range compressed scale of the logarithmic type obtained on the meter by A.G.C. circuits, associated with the main time constant circuits of the meter, and covering a range of 50-60 db. This however, inevitably results in a non-linear behaviour of the receiver and considerable difficulties arise where certain kinds of signal are being measured. In particular, slowly repeated impulses cannot be measured adequately on this type of receiver since overloading of one or more stages of the receiver

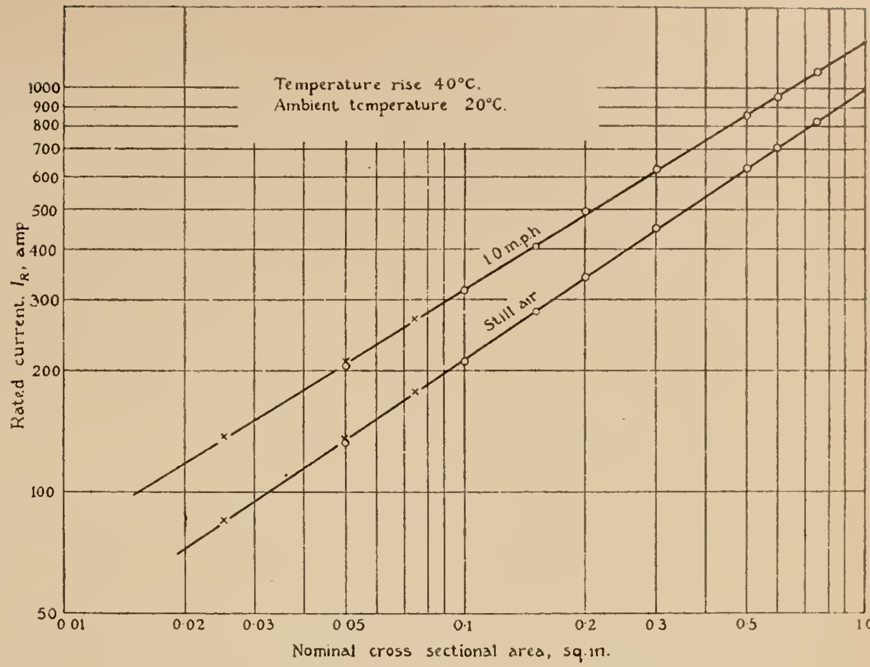


Fig. 2. Variation of current carrying capacity with area. For bright copper conductors. (Shielded from sun.)

occurs for almost any readable indication on the meter scale.

In Europe, on the other hand, small range instrument scales are used, of about 10 db. range and even, in some cases, only a single reference deflection. At the same time the gain of the receiver, the sensitivity of its metering circuits and the signal handling capacity of its output stages are so proportioned that a sufficient overload factor is obtained to allow of a single valued assessment of a single impulse to be made. No A.G.C. is used and the gain of the receiver is only adjusted manually by means of close ratio attenuators or continuously variable attenuators.

It is interesting to note that despite the above differences, measurements made with either equipment of the interference generated by possibly the most prevalent cause — the small electric motor — will as often as not differ by no more than repeated measurements made with either equipment or, say, measurements made with two equipments of the same type.

Electromagnetic Shielding *

Reference might also be made to work on interference caused by industrial and medical radio frequency equipment. In this field, the major effort was directed towards the design of satisfactory shielding enclosures. The subject of shielding offers a particularly suitable field for the application of co-operative research. This is so because the manufacturing of a shielded enclosure is a simple process, whereas highly advanced technical and experimental studies involving the use of complicated test equipment are required to evolve the most economical designs, simple but adequate methods of testing, and sound ways of installation and utilization. The economic factor is of great importance since the cost of a large shielded enclosure can vary from a few hundred to many thousand dollars depending on the method of construction and the materials employed. The primary purpose of the E.R.A. work on shielding was therefore to investigate the performance (i.e. the frequency dependence of insertion loss) of simple enclosures made of least expensive materials, to determine under what condition they may be as satisfactory as the more costly structures. This meant that the investigation was concerned mainly with single-skin enclosures, made of openwork materials like wire mesh, expanded sheet metal, etc.

A relatively simple fundamental analysis [8] can show that two distinct phenomena can give rise to shielding; namely, reflection and absorption of the field energy. Attenuation by absorption in a conducting shield is easily calculable since, in

* Shielding is referred to as screening in British publications.

most practical cases, it depends only on the thickness of the shielding material, measured in terms of the wavelength in that material. Unfortunately, absorption loss in openwork materials is normally negligibly small, so that they can only attenuate by reflection, which is a much more complicated phenomenon. For example, it would not be prudent to calculate the reflection loss of an enclosure without a prior experimental verification of theoretical deductions regarding its dependence — or otherwise — on the following factors:

(1) size and shape of enclosure;

(2) size, shape and position of internal equipment;

(3) earthing and other connections to the shielding material both inside and outside the enclosure;

(4) field component being measured (electric or magnetic), its uniformity and direction of polarization;

(5) direction of measurement (i.e. polar diagram of enclosure) and distance from external source or receiver;

(6) direction of power flow through the shield (inward or outward);

(7) directional properties of shielding material;

(8) quality of bonding;

The above list indicates the extent of investigation required before the results of measurements made with various shielding materials and types of construction can lead to a reliable estimate of their relative efficacy.

The E.R.A. investigation of attenuation by reflection covered the frequency range 0.2 - 150 Mc/s. and included a variety of shielding materials tested under strictly controlled conditions. The results of this investigation and of the simultaneous theoretical study and survey of literature have been presented in a number of research reports issued to members of E.R.A. Some salient points from these results are:

(1) Shielded enclosures of simple design, using openwork materials, can easily be made with bonding so good that the insertion loss is determined by the parameters of the material itself and not by the contact impedance.

(2) The frequency characteristic of insertion loss is then calculable for reasonably simple shapes of enclosure, even if the geometry of the shielding material itself is involved (e.g., the diamond-shaped mesh of expanded sheet metal).

(3) The calculation must be made separately for electric and for magnetic waves. It is quite simple for enclosures small compared to the wavelength, and can be extended even to the region in which cavity resonance effects are present.

(4) There are several types of resonance and some resonant frequencies are critically dependent on internal loading and/or external connections to the enclosure.

(5) Calculation of insertion loss makes it possible to choose the most economical shielding material and form of construction (e.g., single or double skin) which will satisfy a given specificaton.

(6) The insertion loss of enclosures small compared to the wavelength can be found from graphs of the inherent properties of shielding materials. These are now available in the form of frequency characteristics for a wide range of practical materials.

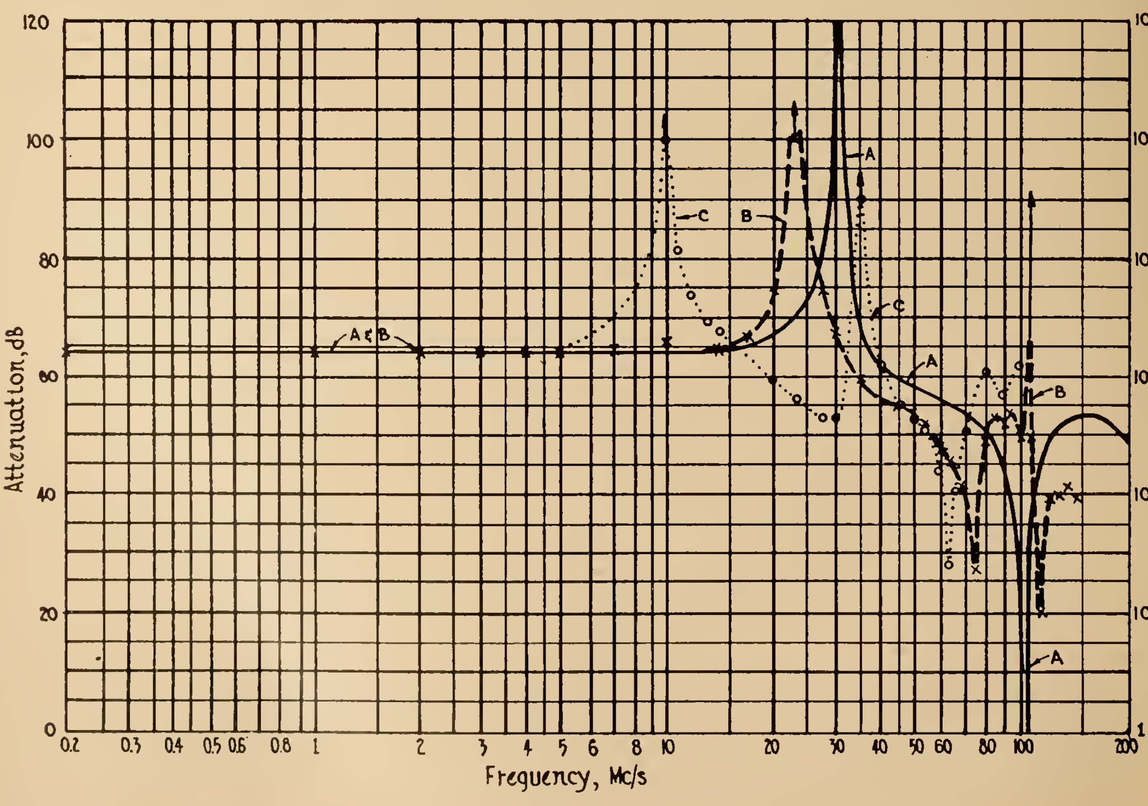
(7) A simple correlation has been established between the properties of shielding materials determined by laboratory measurements on small samples in a test jig, and the performance of complete enclosures, operated under specified conditions.

(8) The method of analvsis developed in the above investigation is also applicable to multi-skin shielding structures.

Performance of a Practical Enclosure

As an illustration of the above, calculated and measured values of elec-

Fig. 3. High frequency resonance effects in electric mode. A, theoretical curve for isolated, empty encl.; B and C, exp. results.



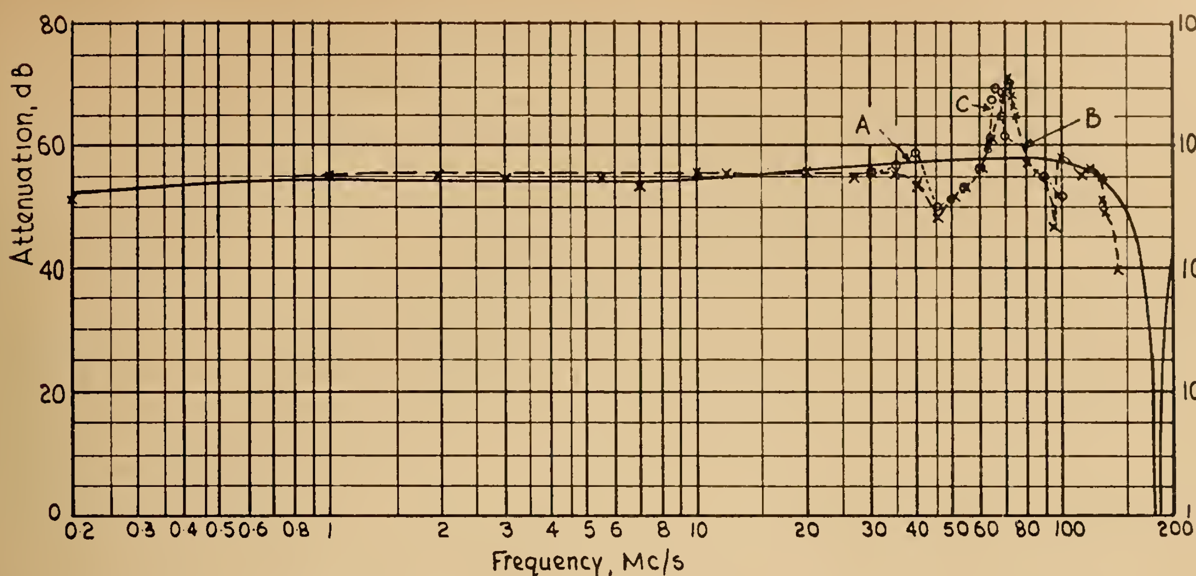


Fig. 4. High frequency resonance effects in magnetic mode. A, theoretical curve for isolated, empty encl.; B and C, exp. results.

tric and magnetic insertion loss are shown in Fig. 3 and 4, curves A and B. These were obtained for a typical small enclosure, of about 6 ft. cube, made of a fairly coarse copper wire mesh (0.04 in. diameter, 0.25 in. spacing). Agreement of theory with experiment is seen to be very good, with a few notable exceptions. These are not due to any shortcomings of the general theory but result from certain deliberate oversimplifications, made to indicate the magnitudes of possible errors. The calculation refers to the inherent properties of the enclosure when empty and isolated, while the experimental results show to what extent these are modified under practical operating conditions. The minimum of electric attenuation at 74 Mc/s. is due to the foreshortened transission line resonance, introduced by the presence of test equipment inside the enclosure. The maximum of electric attenuation at 109 Mc/s. is due to the impedance reflected by the shield into the internal aerial. The maximum of magnetic attenuation at 72 Mc/s. results from a coupling between electric and magnetic modes of oscillation.

The extent to which the insertion loss may be affected by the connection of ungrounded conductors to the shield is indicated by the results of curves C. The only difference in the test condition for curves B and C was that in the latter case the internal receiver and an external steel frame (mechanically supporting the enclosure) were electrically connected to the centre of the shield floor. The observed effect, due mostly to the external connection, is startlingly large in the electric case. The frequency of the first maximum* is altered by 13 Mc/s. from 23 Mc/s. to 10 Mc/s. and a new sharp maximum appears in the response. The attenuation of the magnetic field is little altered by connections not creating new closed circuits, as would be expected.

The above examples indicate the importance of interaction occurring at certain frequencies between a shield and the enclosed equipment. This aspect of shielding received relatively little consideration in practical literature on the subject and in published designs. It should be remembered that a shielded enclosure might provide infinite insertion loss and yet be useless instead of being perfect if, at the same time, it seriously affected the performance of the equipment which it was supposed to protect. This has a bearing on the methods of testing shielded enclosures, a subject which received special attention in the E.R.A. investigation.

Network Analysis

A computer is one of the more important tools in modern research and development work. Small specialized computers can be obtained or constructed at a moderate cost and can be operated by any engineer, but there is also a growing demand for a more exact, more extensive or faster analysis of performance of more and more complex systems. This demand can be satisfied by the use of a large, versatile computer, operated by an equally versatile team of engineers. Here again a co-operative effort is indicated as a good way of supporting a computing centre. This was recognized by the members of the E.R.A. who requested and supported a research and development effort to construct and operate an analogue computer of exceptional versatility. The equipment is of the network analyser type in which electric networks are studied by direct modelling of their electrical parameters, while other systems are represented by means of their electric analogue networks. It is interesting to note that active supporters of the project include members who themselves already operate network analysers on a commercial basis. Far from fearing competition, they expect to gain by being able to pass on to the E.R.A. certain problems requiring special treatment, while utilizing their own equipment more economically on problems suitable for solution by means of routine procedures.

Versatility in a network analyser ([9]) means that the equipment must be applicable to all three fundamental types of network problems, namely:

(i) steady-state, fixed frequency studies;
(ii) frequency response, i.e. steady state, variable frequency studies;
(iii) transient response, i.e. multi-frequency studies.

In addition, the number, range and accuracy of network elements, the accuracy of the measuring system and the flexibility of interconnections should cover the requirements of a large variety of problems.

* This maximum is due to a phenomenon not previously described, named "surface resonance" by the author.

Network analysers are used most frequently on problems arising in the electrical supply industry. There the research problems requiring greater versatility than is usually available in commercial analysers originate mainly in connection with the design of systems and the diagnosis of faults.

Design problems often require diverse studies to be made on a single proposed or existing system. For instance, in a power system it may be desirable to study any or all of the following: load flow, voltage regulation, fault currents and voltages, restriking voltage characteristics, generation and propagation of harmonics, and transmission of surges. Clearly there must be great advantages in having all such studies made by a single team, operating a single equipment, particularly as the results of any one study may necessitate the repetition of some others in altered system conditions. Furthermore, the availability of a versatile equipment encourages full investigations which might otherwise be so reduced in scope that some important details are overlooked.

The advantages of a versatile analyser in applied research show themselves most strikingly in problems involving the diagnosis of a fault on a power system. It is not unusual for several phenomena to be associated with the occurrence of a fault and it may be important to find which of them initiated the sequence of events. In such a problem it is often the combination of results from diverse studies which, when directly available to a single operating team, give the inspiration for the most profitable course of further investigation.

Resources made available by cooperation permitted the development and construction of equipment having the required versatility, in spite of its fairly high cost. The general view of the equipment is shown in Fig. 6. One quarter of the passive elements (one plugboard and two wings of racks) and the steady state control desk have been operational since March 1954. Equipment for transient response studies is also operating and further network elements are steadily being added.

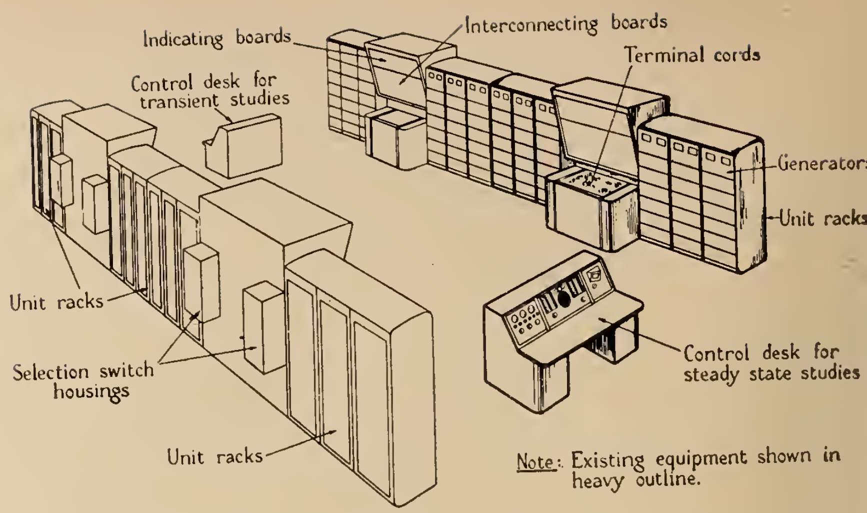


Fig. 5. E.R.A. network analyser. Layout of complete equipment.

A fairly detailed technical description of the analyser has already been published. (10, 11). The only features to be discussed now will therefore be those specifically aimed at overcoming some limitations of the more conventional designs. The main limitations in question are: narrow bandwidth, low accuracy of measurement, low purity of network elements and high cost of providing a sufficiently large number of elements.

Main design parameters

Normal operating frequency	1592 c/s ($\omega = 10^4$)
Frequency range	159 c/s to 15.9 kc/s
Base impedance	100 ohms
Base inductance	10 millihenrys.
Base capacitance	1 microfarad
Base voltage	500 millivolts
Base current	5 milliamperes
Base power	2.5 milliwatts

Each base quantity is numerically represented by 100 units. At normal (i.e. mid-band) frequency, 100 units of capacitance and inductance have 100 units of impedance. The number of network elements of various types and their details are given in Table III. A number of mutual-conductance and non-linear elements not listed in the table, are also available.

The base values of R, L, and C are sufficiently high to make the effect of strays introduced by interconnections very small at the normal frequency, e.g. a stray shunt capaci-

Table III. Details of Network Elements

Type of Unit	Resistance R Max.	Resistance R Steps	Reactance X Max.	Reactance X Steps	Susceptance B Max.	Susceptance B Steps	Connections	Number Available Final	Number Available Present
High impedance (load)	10100	10	1900	5	..	..	Series & Parallel	60	33
Medium impedance (load)	1110	1	1900	5	..	..	Series & Parallel	42	9
Low impedance (line)	110	0.1	110	¼	..	..	Series	126	36
Low susceptance	..	..	..	..	109	¼	..	72	30
High susceptance			..	..	1000	100	..	48	12
π Network	110	0.1	110	¼	2 x 109	¼	π	48	12
Steady state generators			E = 0 – 400%					18	6
Autotransformers, coarse (system transformers)			100% ± 30% in steps of 0.5%					18	8
Autotransformers, fine (load adjusters)			100% ± 10% in steps of 0.2%					64	2
Mutual Transformers			Ratio 1 : 1					12	2
Mutual Transformers			Ratio 2 : 1 or V3 : 1					8	1
Amplifiers and Buffers			Gain 10 : 1 or 1 : 1					12	6

Note: — 48 autotransformers, 24 high impedance units and 24 medium impedance units will be combined into 48 load units provided with individual voltmeters.

Generators and autotransformer units incorporate two-decade reactances.

tance as high as 1000$\mu\mu$F. represents only 0.1 unit, i.e. 0.1 per cent of the base value of capacitance and reactance. Also, a relatively high mid-band frequency facilitates the attainment of reasonably high Q (about 100) in inductive elements. These factors together result in a useful frequency range of 100:1 and a bandwidth of nearly 16 kc/s. for the passive elements. The exceptionally low power level permits the use of small dust-cored inductors, and of miniature vacuum tubes, without loss of linearity. Thus standard small telecommunication components are used throughout the equipment, their low cost and bulk making the provision of a large number of elements an economical proposition.

The use of the low power level was made possible by the development of a suitable measuring system. Fig. 6 shows the control desk for steady state studies, fixed or variable frequency. This desk permits remote selection of measuring points, and displays simultaneously the following quantities:

(i) Complex current I (amplitude and phase) in a selected network element
(ii) complex voltage V (amplitude and phase) between any two selected nodes
(iii) direct phase difference ϕ between V and I
(iv) product $P = VI \cos \phi$ (watts)
(v) product $Q = VI \sin \phi$ (vars)

These quantities, measured by servo-operated a.c. potentiometers, are displayed on dials having a scale length of 50 cm. The design of these potentiometers, one of which can resolve a symmetric voltage of 0.1 microvolt in the presence of an asymmetric voltage of 2 volts (at the same frequency) over 100:1 frequency range, might be of general interest to servo-system designers.

In spite of the low operating levels, the main measuring system has a resolution of 0.1 unit, V and I, i.e. 0.1 per cent for magnitudes around the base value of 100 units. The phase resolution is 0.1° for amplitude levels greater than 10 units. The overall accuracy of measurement depends on the mutual effect of a number of variables, but is normally better than 1 unit and 1 degree at normal frequency, or 2 units and 2 degrees at extreme frequency limits.

Frequency response and transient response studies

The steady state test frequency can be varied over the whole range of 0.1 to 10 times the normal frequency. It is selected by setting of the synchronizing oscillator which determines both the frequency of the energizing units and the frequency to which the measuring system responds. When this frequency is varied slowly, the servo system automatically indicates the corresponding variation of V, I, ϕ, etc., at the selected points, i.e. it indicates the frequency response if the input is kept constant. This facility, inherent in many computers, but unusual in a network analyser, not only extends greatly the usefulness of the analyser for power system studies but is also expected to open new applications for this type of communication and control engineering.

By virtue of its wide bandwidth, the passive system of the analyser can also be used for transient response studies with a suitable energizing and display equipment. Transients containing up to the 100th harmonic of the lowest frequency of interest may be observed with a single modelling factor. Direct superposition of the transient on the steady state response is possible. The possibility of correlating the transient response and the frequency response of a given system is particularly instructive.

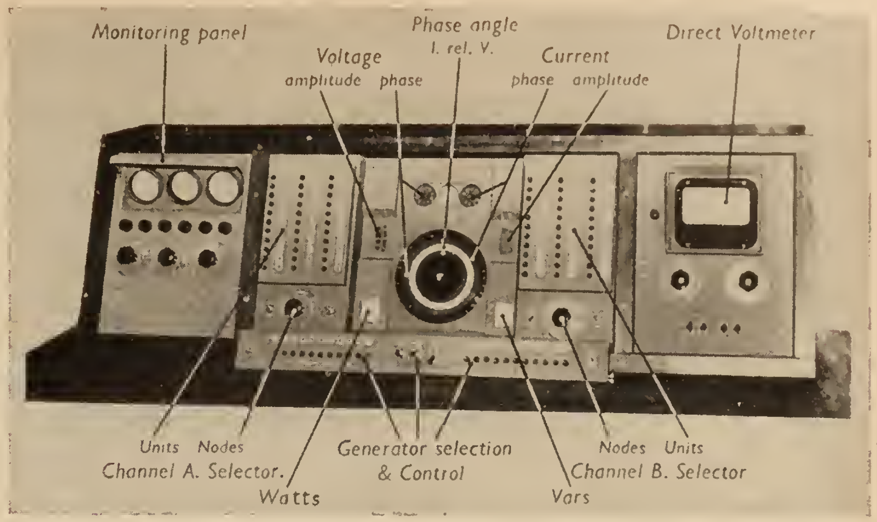


Fig. 6. Control desk for steady state studies.

Example of application

The list of studies made in an actual investigation may serve as a good example of the way in which various facilities provided by the analyser are used to obtain sufficient information about the properties of a system.

Several faults occurred on a system comprising a power station, generating at 20 kilovolt level, grid infeed and a 20 kilovolt cable network. It was required to know if these faults should be attributed to deterioration of insulation, the presence of overvoltages, or the combined effect of both factors. The following studies were found necessary before giving an answer to the question.

(1) Overvoltages and fault currents at system frequency, caused by a solid fault.

(2) Transient voltage at 20 kilovolt busbar on occurrence and clearance of fault.

(3) Frequency response at 20 kilovolt busbars to:

(a) Frequencies generated by fault arc.
(b) Generator harmonics in fault condition.
(c) Generator harmonics in balanced condition.
(d) Triple harmonics generated in an earthing transformer in fault and in balanced condition.
(e) Non-triple harmonics generated in earthing transformer in fault condition.

In conclusion something should be said about the utilization of results. Co-operative research cannot hide its light under a bushel. It is essential that the results should be made available to all the members interested, in such a way that they are clearly understood and can be properly used in industry.

Accordingly an important part of the E.R.A.'s organization is the Information Bureau and Technical Liaison Department. The former which also controls the library facilities deals with the dissemination of existing knowledge including E.R.A. reports of which about 100 a year are now

(Continued on page 40)

Precast Panels as Formwork for a Gravity Dam

J. S. Ellis, JR.E.I.C.
Department of Engineering, University of Cambridge, England

THIS ARTICLE describes the use of precast concrete formwork for the construction of a large gravity dam. The structure, the Cluanie Dam in Scotland (Fig. 1), is the first large project in Britain to use such formwork. The following points will be considered: a description of the panels, their advantages and disadvantages, and sources of information. (Fig. 1, general view, above.)

Description of the Panels

Figures 2 to 4 show the panels and Figure 3 clearly indicates the differences between the three types. The upstream panels are each 4,480 lb. in weight while the downstream ones are somewhat heavier at 7,280 lb., and the contraction joint panels are 3,360 lb.

The sizes of the panels are dictated by: (a) depth of lift—the vertical height of a panel is equal to the depth of a lift of concrete; (b) weight—the capacity of the small mobile crane used for erection limited the size; (c) final adjustment—this was done by hand and it was considered easier to adjust several small panels than one large one.

The panels were cast in moulds assembled on a vibrating table; the moulds were stripped generally after 5 hours and the panels were then cured for 7 days. The panels were inspected before use, and the number of rejections was small and resulted mainly from mishandling during stripping. The peak output was in excess of 500 per week.

In erecting the upstream panels a layer of mortar was placed in groove A (Fig. 2) of the lower panel to form a seal. (Bituminous filler was tried in the early stages but became badly deformed during erection and its use was therefore discontinued.) Then precast concrete cylinders, called joggles, were placed in grooves B. The upper panel was lowered into position so that the grooves G fitted over the joggles and so that the tail C of the upper panel fitted loosely into pocket D of the lower one. Thus the upper panel was located and yet possessed a limited amount of pivotal movement about the upper edge of the front face of the lower panel. Concrete wedges were inserted round the tail and when the panel was set truly the pocket D was filled with grout to make a solid joint. The joints between the panels were then pointed.

During the course of the concreting operations, concrete was rammed down channel E to ensure that no voids were left at the back of the tails.

The procedure for the contraction joint and downstream panels was the same, except that in the latter case precast struts were placed behind the panels to support them at their correct slope (see Fig. 4). A study of Fig. 4 will reveal that the downstream panels had no tails.

Only the upstream and contraction joint panels were reinforced and the reinforcement was placed in the tail and around the top pocket. This

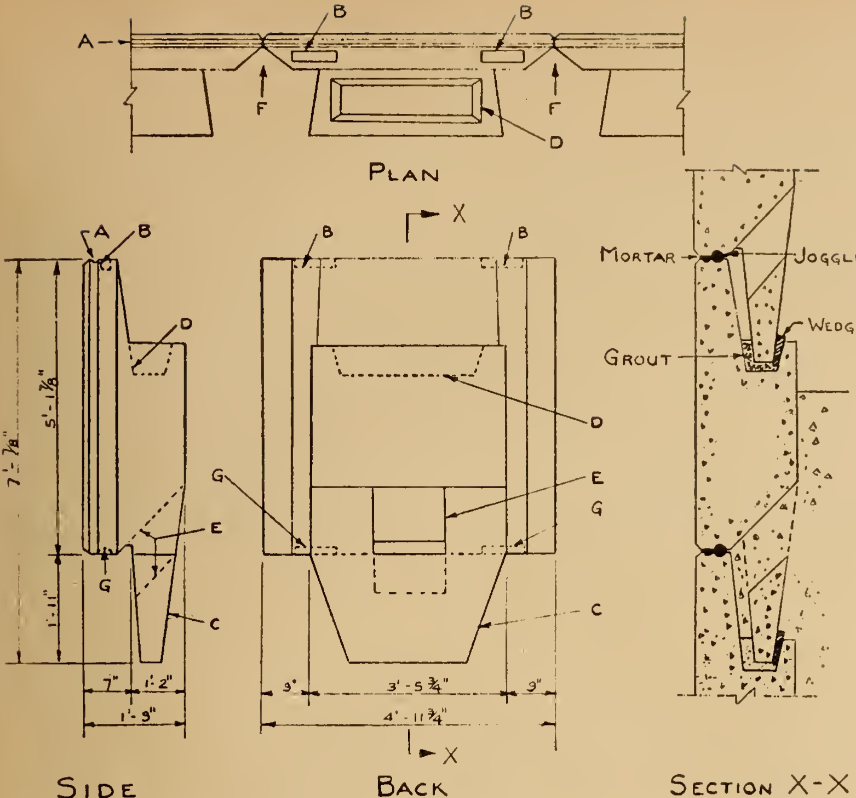


Fig. 2. Diagram of layout of upstream panel

Fig. 3. View along the dam showing panels in position

steel was put in to strengthen the panel against damage due to handling and erection.

Advantages and Disadvantages

The economic factors which favour the use of precast panels are: (a) a project of sufficient size to warrant the expense of setting up a block-casting yard; (b) difficulty in obtaining carpenters; (c) a relatively high price of dressed timber which is used in normal wooden formwork; and (d) a shortage of steel, which is against the use of steel forms.

The panels were erected without the use of external scaffolding; this saved money and promoted safety. As they extended above the upper level of the dam during construction the panels served to protect the workmen.

It was not considered advisable to eliminate the rich mix of concrete on the upstream side of the dam as it was feared that with the panels there would be more potential joints to permit leakage. On the downstream side, however, the rich mix was not used.

There was no evidence to show that the mass concrete shrank upon

setting and induced cracks between the panels and the mass concrete.

The use of these panels was considered by the contractor to be justified economically and it was felt that they would certainly be used again to build another dam in the same conditions.

Sir William Halcrow & Partners, M.M.I.C.E., of London, England, who were the consulting engineers for this project, provided the writer with the information contained in this article. The patent specification for the precast panels is held by the Mitchell Eng. Ltd., of London and by J. W. Moore, of Stamford. The contractors were the Mitchell Construction Co., and the owner is the North of Scotland Hydro-Electric Board.

Acknowledgments

The writer wishes to acknowledge gratefully the generosity of the Athlone Fellowship Committee for financing his visit to the Scottish dams where he saw the use of the precast panels. He is also indebted to C. M. Roberts, M.I.C.E., a partner of Sir William Halcrow & Partners, and the North of Scotland Hydro-Electric Board for their assistance in the preparation of this article.

Fig. 4. A series of downstream panels in position.

Fig. 5. Close-up of tail, channel, and wedge. (Below, right)

200,000 kw. Reheat Boiler *(continued from page 14)*

input required for pressure regain after the load pick-up may be supplied while full steam output is being delivered to the turbine.

To protect the turbine from excessive steam temperature fluctuations during severe load swings the boiler must be able to maintain full load steam temperature at fractional loads, and must have sensitive and fast steam-temperature regulating devices. The combination of boiler design, flue gas recirculating to the hoppers, and spray attemperation on both superheater and reheater provide these features for this unit.

In conclusion, we may summarize some of the major considerations which guide boiler design[1]. The fuel to be burned and the approximate size of the unit required fix the general design of a steam generating unit. The specified performance at full load and at partial loads determines the sizes and to some extent the arrangement of the furnace, superheater, reheater, economizer, air heater, and firing equipment. Available building space, indoor or outdoor service, anticipated load cycle, draught loss, provision for soot blowing equipment, and other matters affect the arrangement details.

There has been a very rapid change in the design of units in the last ten years. Operators have been confronted with new problems, increases in the cost of fuel, changes in generating cycles and in the size of units. These requirements have received intensive study, and present-day designs have been developed to meet these changed conditions. A good design today will provide a unit from which reliable, efficient and reasonably trouble-free operation can be confidently expected.

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Ore Transfer Facilities at Contrecoeur, Quebec

D. H. Sharp, M.E.I.C.,

Assistant Manager, C. D. Howe Company Limited, Montreal

DURING 1956, iron ore mined at Knob Lake by the Iron Ore Company of Canada Limited was shipped from their port at Seven Islands (described in the January 1955 issue of *The Engineering Journal*) in ships varying in size from 9,000-ton canallers to 45,000-ton ocean-going ore carriers.

The Seven Islands port opened on July 31st, 1954 and before the close of navigation at the end of November, had shipped 1,700,000 long tons. In 1955, 7,500,000 long tons were shipped, and in 1956, 12,000,000 long tons were shipped. The design capacity is 10,000,000 long tons. In 1956, 2,750,000 tons of this ore came up the St. Lawrence on its way to lake ports in the U.S.A. in ships too large to get through the canal system, and the ore was reloaded into smaller ships and railroad cars at the ore transfer facilities built for this purpose at Contrecoeur, Quebec; 2,206,000 tons were loaded into canallers and 460,000 tons into railroad cars, the balance of 84,000 tons remaining in the stock pile over the winter. These facilities are about 25 miles downstream from Montreal, on the south shore.

The sketch above shows the general layout of the dock area with a large vessel and a canaller berthed.

The facilities consist of a dock with capacity for unloading a 28,000-ton ship and loading canallers averaging 2,275 tons at the same time, or of loading two canallers at once if no large ship is berthed; two travelling unloading towers each equipped with a clamshell bucket capable of lifting 12 long tons of iron ore; conveying equipment to transfer from the unloading towers to a canaller loading tower and to railroad cars; and a storage pile area where the unloaders may place ore if no ships are available in which to load it. Provision is made to erect a 150-ton stiff leg derrick at the downstream end of the dock and for the loading of ships with it, should this be required. A small administrative office, machine shop and pump house are the only buildings.

An approach channel 300 feet wide and providing a minimum of 35 feet of water allows large loaded ships to berth. After they are unloaded and their draught reduced, they may turn around in the area between the dock and St. Lawrence river channel. Small ships, such as canallers have great freedom of manoeuvre as they are of very shallow draught and can approach without using the channel.

Unloading starts as soon as lines are made fast — the sequence of emptying holds being set by the ship's crew. The unloader tower operator has good vision into the hold and his rate of unloading is mainly governed by his dexterity. A 35 to 45-second cycle is maintained when unloading from ship to conveyor belt and a 55-second cycle when unloading to the stockpile. Before arrival of vessels, the aprons of the unloaders overhanging the water are raised to clear the ships' superstructures, and this is also necessary during unloading operations, to allow the towers to move past the superstructures to the forward hatches.

The clam shell bucket of 12 long ton capacity dumps into a 150-ton hopper over a 48 in. manganese pan feeder feeding the 36 in. dock conveyor. This conveyor in turn reloads on to an inclined belt feeding into the canaller loading tower. The ore is weighed on the inclined belt by a standard conveyor weigher.

The canaller loading tower consists of a 42 in. retractable horizontal "shuttle" belt conveyor mounted on a moveable frame, motor - driven through a rack and pinion. All conveyors start and stop in sequence and are protected from being fed when not running at full speed by the use of centrifugal switches. The canaller is moved to maintain trim fore and aft as the tower is fixed. The shuttle conveyor may be moved while operating to trim athwart ship.

As the canaller is a small ship, loading with one tower at a time at maximum capacity (1,000 long tons/hour) is fast enough. Therefore, while towers are unloading freely, only one of them feeds the dock conveyor and the other unloads to the stockpile. During cleanup, when unloader capacity is reduced, both may feed the dock conveyor. Average capacity for unloading an ore carrier with properly designed cargo space is 800 tons per hour per rig. As soon as the large ship is unloaded, the stock pile is rehandled back to the dock conveyor. This arrangement is convenient and necessary since so many 2,200-ton canallers are required to equal a 20,000- or 28,000-ton ship, and time must be available through use of a "surge pile" to allow for the arrival and departure of canallers and the moving of them during loading. In this way, unloading of the large ships may take place at maximum speed whatever is happening at the canaller berth.

The dock has three dolphins in line with its face on the downstream end, and one set back towards the shore at right angles with the others. Dredging has provided a turning basin here to receive the stern of a ship leaving the dock. The ship may warp downstream and pivot around the last dolphin with a line to the one ashore to assist the manoeuvre; this enables it to leave the dock heading upstream and at an angle to the current.

Fig. 2. View of the dock conveyor (left) and inclined belt feeding the canaller loading tower (right centre).

Should a ship wish to load at the 150-ton derrick, it may use the dolphins and the dock for mooring. A siding ends at the derrick so that cars, locomotives, and freight may be loaded. The siding connects with the C.N.R. track feeding Sorel from Montreal. A road runs parallel to the railroad siding part of the way, connecting the dock area to No. 3 highway. This road is at the same elevation as the top of the dock and has been run to the upstream end of the dock, so that its embankment will serve as protection against flood water which could otherwise flow behind the stockpile area to the railroad siding.

Water is pumped from the river and filtered and treated to provide the domestic supply for the small staff. A well was considered but the experience gained at a neighbouring property where brackish water and gas were encountered, was not encouraging. A prefabricated building provides office space, stores, and a small machine shop.

The dock is of steel sheet pile construction, the unloading face being 751 ft. 5 in. long, piling being 83 ft. long and driven in clay with bands of sand. A rock blanket and gravel and sand filter are placed against it and the area behind filled with sand brought in from elsewhere. The piling is tied back with one row of tie rods.

Fig. 3. Discharging from loading tower. Empty canaller moored at left.

Dredging of the channel and turning basin was done by a suction dredge with cutting head, the material being clay with some small boulders. This material was piled ashore downstream from the dock as it could not be used for fill. It was possible to walk on it shortly after it had been deposited.

Dolphins were constructed of groups of hollow piles, each made up of 3 steel sheet piles. These were encased in concrete caps 10 ft. thick x 20 ft. x 10 ft. and connected by tie rods, which also served to support wooden walkways connecting the dolphins. There is a bollard on each dolphin. The inshore dolphin is tied back to the downstream wing wall of the dock by cable. The river bottom was such that it appeared advisable to tie the dolphins together and to the dock.

Foundations for the 12-ton unloader rails consist of concrete walls on timber piling with cross wall ties every 25 feet. Foundations for the conveyors are spread footings on the rock fill and the administration and shop building (120 ft. x 40 ft.) is built on a monolithic reinforced concrete slab on fill material which was built up about a foot above the surrounding yard level. The storage area is of sand placed on clay. The 100,000 long ton storage area is permanently floored with a layer of lean ore about 2 feet thick. The elevation of this floor is about 2 feet below the yard level. A concrete wall separates the storage area from the dock area and also supports the steel structure supporting the power supply to the unloaders. Power for the project is received from the utility at 33 kv. and stepped down to 600 volts by means of a 2000 kva. substation. Three single-phase 667 kva., 33 kv., 600-volt transformers are used with a fourth spare transformer installed. Main low-voltage switching equipment and utility metering equipment consists of a switchboard located in a small prefabricated building adjacent to the transformers.

Each of the two unloading towers has two 300 h.p. W.R. bucket motors, a 150 h.p. W.R. trolley motor, two 40 h.p. W.R. propelling motors, a 5 h.p. S.C. rail clamp motor, a 60 h.p. W.R. apron hoist motor. In addition, each tower has an apron feeder powered by a 15 h.p. S.C.T.E.F.C. motor.

Power to both unloading towers is taken over a 3-conductor extruded aluminum system, each conductor being paralleled with a 750 m.c.m. copper booster cable, and the system rated 1500 amperes continuous. Power pickup to each unloading tower is by means of graphite collector shoes rated 1000 amp. for each conductor. In addition, each unloading tower has two control wires taken to it over a cable reel for sequence operation of the apron feeder.

The dock conveyor and inclined conveyor are equipped with 75 h.p. T.E.F.C. S.C. motors and fluid couplings. The dock conveyor is equipped with a thrustor brake so that its long decelerating time will not result in a pile-up of material at the transfer point.

The shuttle belt and shuttle transfer drives are also equipped with totally enclosed S.C. motors. The shuttle belt and apron feeders are equipped with traction type fluid couplings. All conveyors and the apron feeders are interlocked so that they may be started and stopped in correct sequence from the "all start — all stop" pushbutton in the ship loader. Double voltage relaying and centrifugal switch interlocks ensure that material will not pile up in the event of the failure of one drive. Each apron feeder may be stopped independently of the other conveyors from the ship loader.

Each conveyor and the apron feeders can be run independently of all sequencing from the "hand-off —automatic" selector switch near each drive motor. "Emergency stop" switches are placed at strategic locations along the various conveyors.

An 80-foot steel tower serves to accommodate flood lights for night operations. Floodlights on each unloading tower and on the ship loader supplement the tower lights.

The unloader towers are 91 ft. 6 in. high and about 30 ft. wide and are supported on dual 132 lb. rails. The total span of the arms is some 210 feet and the total lateral travel of the clam shell is 180 feet. The bottom chord of the arm is 62 ft. 10 in. above the rail, and vertical clam shell travel is about 90 feet. Bucket hoist speed is 308 feet per minute. Horizontal or trolley speed is 720 feet per minute, maximum.

The clam shell may be turned through 90 deg. by the operator to facilitate unloading from ship's hatches. The towers may be moved along the dock at 75 feet per minute and can approach to within 42 feet of each other. Bumpers are provided in case of collision. Warning horns sound while towers are travelling along the dock.

Communication between the office and tower operator and other personnel is by radio. Loud-speakers are placed at the back and front, in the cab, machinery room, and at the hopper of each unloader, and at the reload point between the dock conveyors and in the canaller loading tower. All conversations are heard over all loud-speakers. A portable radio is used which allows the user to speak over the loud-speaker system, in which case he also hears his reply over the loud-speakers.

All hoisting and traversing machinery is housed in the towers on one floor about 73 feet above top of rail. One and one-eighth inch diameter steel wire rope is used and is bought on a large reel which is supported in the tower so that new rope may be fed off it into the rope system as required; the rope deemed unserviceable is cut off at the clam shell end. This saves replacing all rope when one spot becomes worn.

Fig. 4. Dolphins, spaced 80 ft. apart, at Contrecoeur transhipment area allow large ships to manoeuvre without tugs.

Meeting the shortage of Engineers and Scientists

J. W. Barker, M.E.I.C.

President, The American Society of Mechanical Engineers
Chairman and President, Research Corporation, New York

Address to the ASME-EIC Engineering Education Conference, London, Ont., October 19, 1956

CANADA and the United States are facing a most serious problem which threatens to place limitations on their rapid technological progress. In neither country are we training sufficient numbers of those highly qualified engineers and scientists so essential to meet the demands of government, education, and industry as these institutions expand to service the requirements of our rising standard of living. Nor are we training sufficient numbers of technicians to support and amplify the work of the engineers and scientists.

I want to stress from the very beginning that it is more important for both our countries to emphasize "quality" rather than sheer numbers of engineers and scientists. Although it is true that we require *more* engineers and scientists, it will be the "quality" — the creativeness, the ingenuity, the comprehensiveness of background — which will determine the rate of technological progress.

Our North American continent is in fact an entity, complete in itself even if divided by imaginary boundaries into two political units. It interacts, it is true, with other national entities but nevertheless contains within itself all the ingredients necessary for its growth and success — or for its decline and failure. Nowhere else do we find two nations more closely linked in their economics, more closely linked in their way of life, their thinking and their actions, yet completely independent politically. We are truly an entity.

This is a fact we cannot repeat too often, for it may help to clear up some of the present confusion about our competition with the Soviet Union in the training of scientists and engineers. You have all heard the figures that tell how the Russians are outstripping us in this respect. Those figures are valid and they are significant. I should be the last person in the world to ridicule them. But, I think it is more important for us to look at our engineer shortages in terms of the difference between what we have and what we need, in terms of the "quality" of our educational and professional training. After all, it should be our purpose to solve this problem in terms of our own requirements, and not in terms of a frantic contest to make our statistics look better than those of the communists.

Let us first examine this numerical shortage, therefore, in terms of the only index that amounts to anything —the ratio between the number of engineers available and soon to be available, on the one hand, and, on the other hand, the numbers needed and soon to be required.

Using that index we know that these shortages are now severe and probably will become worse before they can become better. In both our countries, we had a low birth rate in the mid-1930's and we have had a steeply rising curve of births since the mid 1940's. Our present production of qualified engineers can only come from those age groups born in the mid-1930's, yet our industries must expand to service the rapidly growing population due to the higher birth rates of the last ten to twelve years as well as to supply our expanded "standard of living" and our phenomenal technological progress. Added to all this are the production demands to meet our mutual defence needs in the "cold war."

Every advance in technological progress and every demand of mutual defence creates a fantastic increase in the demand for engineers. Every modernization of existing plant, every application of automation, every new product, every new defence weapon, all these increase the demand for engineers and scientists. And the growing school population arising from our increased birth rates creates a simultaneous demand for more qualified teachers of all types but particularly a severe demand for teachers of science and mathematics which can only be supplied from those same age groups of the 1930's which have to supply the industrial and governmental demands. The schools have been and are having very severe problems in securing qualified teachers to train our potential engineers, for their salary scales are much lower than those of industry and the teacher shortage means a reduction in our ability to train more engineers. It is a vicious cycle and can mean trouble for both our countries' continued progress.

So much, for the moment, on the numerical shortage. Let us now consider the quality question. The extremely rapid technological advances of the post war years have resulted from our ability, first, to make new scientific discoveries; second, to visualize or rather to create the means to apply them to practical uses; third, to create the demand for these new products or means of production and.

finally, to seek constantly for means to improve them either in terms of greater usefulness or in terms of lower costs. Increases purely in the numbers of engineers and scientists, though essential, will not keep our technology in the forefront of world progress. Just as the adoption of automation in a production line increases the need for skilled operators and reduces the demand for unskilled workers, so, too, does technological advance increase the need for ever higher qualified and more creative engineers and scientists to pioneer the way to continued technological advances.

The ancient Egyptian civilization, which was a marvel of its age, was built by hundreds of thousands of peasant farmers and slave labourers guided by a handful of rulers and engineers. Our North American standard of living is operated by a working force of some 75 million men and women, of whom only a fifth could possibly be classified as "unskilled workers."

Lee Du Bridge, the president of California Institute of Technology recently said "This great civilization of ours has one terribly important property that we often fail to recognize —it cannot be operated by dopes! The key figure of the future will not be the frustrated automaton, but the educated man with his feet on the desk — thinking!" It is highly probable that some future historian will describe our technology as "a master plan designed by a few geniuses for execution by a great many geniuses."

To revert again to the numerical shortage problem, in the United States the Special Survey Committee of the Engineers Joint Council recently published results from the answers to questionnaires received from 363 industrial and 51 governmental organizations which employed on 1 January, 1956 about 140,000 engineering graduates or about 25 per cent of the U.S. total. From the 140,000 employed on 1 January they expected to lose from all causes, including military draft, 10,800; they expected, or rather *hoped*, to hire from the 1956 graduating classes 11,300 B.S., 1,100 M.S., and 600 Ph.D. graduates, a total of 13,000; while from earlier classes (which can only mean hiring away from somebody else) they expected to hire 9,500. From military leave they expected 2,000 to return to employment, making total *net expected* engineering accessions for the complete year of 1956 to be 14,100 — a net increase of 10.1 per cent. But, in the same survey these same organizations stated their requirements as 14,500 B.S., 1,400 M.S., 964 Ph.D's from current classes and 11,700 from earlier classes or a total *net requirement* of 20,000, leaving a stated shortage of about 6,000 engineers in a 25 per cent sample of all U.S. industrial and governmental engineering employment. Hence, if the same ratios exist in the remaining 75 per cent, then the engineer shortage must be about 24,000. And it must be remembered that educational and scientist shortages are *not* included in such computations.

It was expected that 30,000 B.S. degrees in engineering would be

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awarded last June but some 6,000 of these were expected to return for graduate study and hence would not be available for full-time employment. With a net of 24,000 available and industry and government *expecting* to hire 45,000 B.S. graduates it is evident that some were seriously disappointed in their recruiting results. Although I have seen no comparably detailed studies in Canada, my Canadian colleagues assure me that your situation is almost exactly the same as ours.

This, then, is a reasonably accurate picture of the present-day numerical shortages based on present production levels.

Returning to the "quality" problem, I want to point out from these survey reports that the reporting organizations were seeking 2,300 advanced degree men in comparison with 14,500 bachelor degree graduates, or 16 per cent advanced degree men. If an advanced degree is an indication of "quality" training, then it must be evident that the reporting industry and government organizations were seeking to improve the quality as well as to increase the numbers of their staffs. I am not going to argue whether advanced degree instruction does *ipso facto* increase the creativeness of the student or whether it simply crams his head with more theories. Neither am I going to argue whether it is always the more qualified B.S. graduate who goes on in the engineering school or university to an advanced degree nor whether the graduate school faculties eliminate the uncreative, less qualified students and carry on to the graduate degree only the truly qualified engineer or scientist. I am prepared to argue that all these facts indicate that we should give great weight to improving the quality of our entire instructional practices.

Will the demand for engineers remain in the near future as high as it is at present? For both Canada and the United States it is reliably reported that gross national product, though it has levelled off somewhat after its sensational rise to over 400 billion dollars per annum for the U.S., will continue for 1957 at least at its present rate. There are almost no economists who are predicting a serious drop in our gross national product during 1957. Whether or not this rate can be maintained indefinitely will depend somewhat on whether or not the cold war remains at its present temperature and whether or not inflationary processes continue. But, every increase in wage rates makes an increase in automation more probable, every new process and every improvement in production practice makes more and more demand for engineers and scientists.

It has been stated that the phenomenal rise in gross national product and the present tendency for this rise to level off above the 400 billion annual rate for the United States mean that even if we have had some engineering shortage, it has not hindered production of goods and services. I have considerable doubt whether such an argument can hold water. Although gross national product is the best, possibly the only index available, it must be remembered that it measures not only the actual quantity of goods and services produced but also the price which those goods and services command on the world market. Any serious monetary inflation must of necessity move the gross national product index higher; even with no increase in the quantity of goods and services produced.

Our American experiences in the depression of the 1930's have demonstrated that companies which shorten sail by reducing research and engineering take longer to recover from the depression than those which increase their research engineering in hard times.

When we put all these factors together it seems most improbable that there will be a material slackening in the demand for engineers for some considerable number of years ahead. Even when we can meet the numerical shortage there will still be a tremendous need for a higher percentage of more highly qualified engineers and scientists.

We have already seen that our educational systems are not producing enough to meet present demands. We have seen the need for improving our educational processes. We have seen that education will require additional competent teachers. We have seen that not until the increased birth rate of the 1940's begins to increase the number of B.S. graduates will we begin to meet the annual demand. We have seen that present and past shortages have left large gaps in the various levels of engineering staffs. We have seen that the teaching requirements to handle the increased school populations resulting from increased birth rate will require large numbers of highly qualified teachers, particularly in science, mathematics and engineering. We have also seen that not only do we require more engineers and scientists but that we seriously need to improve the quality and to seek out and increase the number of highly qualified, creative engineers and scientists.

What Can Be Done

Now what can be done to break this vicious cycle and permit both our countries to maintain and even to increase our technological progress and to make possible a constantly rising standard of living, which I believe can only be achieved by constantly increasing production of goods and services at prices the consumers can afford to pay.

First, I believe we must critically examine and ruthlessly weed out any practices which tend to use our trained engineers and scientists at less than their full scale capacity. We cannot afford to use any engineers or scientists on any tasks which can be performed by trained technicians. We cannot afford to use creative engineers on more or less routine engineering tasks.

Second, we must establish and strengthen programs to provide technicians qualified to undertake the more routine practices under the direction of engineers and scientists. And this relief of our trained engineers and scientists from sheer routine means we must use qualified secretarial help in increasing proportion.

Strengthen Teaching

Third, we must strengthen and actively support the highly qualified teaching of science and mathematics throughout our secondary education. Such instruction is vital for those who will undertake engineering or science as a career but it is also important for all our children who will live in a civilization built by engineers and scientists if the remaining portion of the adult population is to appreciate, to understand, and to utilize the possibilities of technological contributions to an improved standard of living. To me it is heartbreaking to hear reports from one of our great U.S.A. state universities, which for some three years administered achievement tests to all entering freshmen, that nearly 30 per cent failed to pass even fifth grade arithmetic! How can they expect to balance a check book, let alone comprehend what impacts technology is making on our entire civilization? It is truly said that technology must be related to social progress, but it is equally true that social sciences must understand technology.

Fourth, we must improve the social and financial position of our teachers both in secondary and collegiate level education. When you stop to think that the teachers have contact more hours per day with, and hence more influence upon, the children and youth than do the parents or the church, surely those to whom we thus commit the intellectual growth of our youth should be recognized as among the most important citizens in our community. When discussing this problem recently with President Eisenhower, he told me of one of his experiences while president of Columbia University. He had been invited to speak befor a group of well-to-do parents on "the problems of our public schools." He said that he commenced his talk by asking any parents to rise who had entertained in their home during the past year any teacher of their children. Not one stood up! Then he went after them hard on the basis that as long as the teachers were second class citizens, not worthy of being invited to their homes, how did they expect to be able to improve public school instruction. There is a great lesson for all of us to learn out of this story.

Fifth, what about our engineering and science colleges? Here is the apex of our formal educational system for training engineers and scientists. Yet these colleges, whether privately or publicly supported, are having a desperate time retaining sufficient qualified staff against the higher stipends and opportunities offered by industry and government. I know of one U.S. state engineering school department of mechanical engineering which lost 40 staff members last May and which, in spite of increased enrollments and a slightly increased salary scale, has only been able to secure 30 replacements so far this academic year. This is by no means an isolated example. Should such a trend be continued for long we would certainly decrease the quality of education afforded our student engineers when the great essential is to improve quality. Even highly dedicated teachers who remain on college staffs because they love to teach cannot carry excessive teaching loads and still give first class instruction to the coming generation.

Approaching the Problem

However, the topic assigned me for this joint E.I.C.-ASME meeting was "meeting the shortage of engineers." So far I have only sketched out how serious this shortage is, how the demand for engineers is most probably going to continue at least at its present level, how this must now and for the immediate future be met from age groups coming from a low birth rate, how the technological progress is apt to maintain the present demands as a minimum, and how the increasing birth rate since the war has tended to accentuate the shortage problem and prevent its solution in the near future. I have touched upon the necessity for industry and government to reassess uses of engineers and scientists, and the desirability of substituting wherever possible other personnel in any work now being done by engineers and scientists which can possibly be done by others. I have stressed the desirability of improved quality rather

(Continued on page 34)

DISCUSSION

of Technical Papers and Other Articles

LATERAL RIGIDITY OF STEEL BUILDING FRAMES

J. L. de Stein, M.E.I.C., and J. O. McCutcheon, M.E.I.C.

The Engineering Journal, 1956, October, p. 1343

Chas. W. Deans, M.E.I.C.[1]

The article dealing with lateral stability and rigidity of steel building frames is verv timelv as presented by Messrs. de Stein and McCutcheon in view of the growing use of lightweight floors and panel type light weight building facings in metal and glass flexibly attached to the building frame.

In the Vancouver area recently the post office building and the Burrard buildings presented interesting problems. Both of these buildings were designed for earthquake and wind forces as well as the dead loads peculiar to each type of structure and their functional uses. The heavy floor and equipment loadings of the post office made earthquake forces of prime importance due to the weights involved and the 8 to 9 storey height. Here the lateral deflections were not a major consideration.

In the case of the Burrard building however, we have a structure with transverse bavs of 25 ft. 6 in. x 18 ft. 0 in. x 25 ft. 6 in. with a height of about 225 ft. in 20 stories. The floor was of a metal ribbed type with thin concrete slab and the outer wall cladding of the glass and aluminium construction, very light indeed. Here we find that wind is a major consideration in the lower stories while earthquake is a design criterion in the upper stories, all as far as stresses are concerned. However, when a deflection calculation is made under the assumption of full wind forces according to the National Building Code, it is found that many column and beam sections have to be increased in stiffness merely to satisfy a certain maximum tolerable deflection in keeping with natural frequency characteristics and actual physical sensation of the human body to repetitive large displacements.

It was felt that the limiting displacements per 11 ft. to 12 ft. 6 in. stories should be limited to about ⅛ in. and 3/16 in. This amounts to approximately 1/800 to 1/1000 of the height. As the Burrard building was on firm sand-clay-gravel this order of displacement ratio was deemed satisfactory. It may be that for other foundation conditions of a more yielding nature the limitation of displacement would be of the order of 1/1500 of the height.

As the authors rightly point out, the designer has to consider many factors in the design of modern building frames in steel. In the taller types it would seem imperative to use the all-welded beam to column connection developing the beam stiffness at the column face or even overdeveloping this stiffness to give additional over-all stiffness to the frame.

The newer concept of applying plastic limit design methods to such tall and lightly loaded building frames with light floors and wall cladding certainly will have to be checked by a proper elastic deflection analysis to ensure that lateral displacements do not exceed those beyond which the human body can tolerate or the occupants can experience without discomfort.

In tall buildings one must also consider the added lateral displacements due to column shortening and lengthening due to a vertical cantilever action of the building frame. The total displacement at each storey is also required to determine the natural frequency of the building frame. I feel that this is an important calculation when comparing frame frequency with natural ground frequency for the different kinds of foundation conditions encountered.

As the authors remark the whole question of permissible lateral displacements and natural frequencies is very complex and much research needs to be done in this field and the information from field measurements at many sites throughout the world should be gathered and distributed to all structural engineers and architects who will have to deal with such design problems.

[1]Chief Engineer, Western Bridge and Steel Fabrication Limited, Vancouver.

AN HISTORICAL REVIEW OF THE SEAWAY

The Engineering Journal, 1956, September, p. 1126

General A. G. L. McNaughton, M.E.I.C.[2]

In reading the "Historical Review of the Seaway" I was very interested to observe that the map at the head of the article shows the boundary line as north of Adams Island, leaving the Gut Channel in United States territory. Adams Island is the small island to the north of the west end of Isle aux Galops.

The passage between Adams and Galops is called the Gut Channel and it, together with the Gut Dam, was a subject of very serious controversy during the proceedings of the International Joint Commission on the St. Lawrence Power Applications in 1952. Actually the dispute over the Gut Dam might have prevented the issue of the Order, but in actual fact agreement for its removal provided a last gesture by the Canadian Commissioners which induced two of our United States colleagues to vote with us.

Despite the authority of the Office of Public Works, Toronto, 1856 (who published the map referred to above —Ed.) the boundary in this troublesome region runs down the middle of the Gut Channel and always has done so since the demarcation carried

[2]Chairman, Canadian Section, International Joint Commission.

out by the Commissioners under the Treaty of Ghent and recorded both in the Treaty itself and in their declaration signed at Utica on 18 June, 1822.

I have verified this by looking at the original certified reproductions held by Canada and now in the possession of the Canadian Section of the International Boundary Commission. The Commission has kindly undertaken to provide a reproduction which, because of its interest, I propose to send to you for the Engineering Institute Library.

The Commission also provided me with a copy of the boundary as revised under Article IV of the Treaty of 11 April, 1908, which was adopted by the International Waterways Commission at Buffalo, N.Y., on 15 August 1913. The revision which is the present boundary substitutes straight lines from point to point for the rather complicated lines at a fixed distance, generally 100 yards from the nearest shore, which was adopted by the Treaty of Ghent Commissioners.

This area is now traversed by the Galop Cut for the St. Lawrence power and navigation project and the various islands will be lost by the disposition of the fill. In consequence I thought this information might prove to be of interest to the members of the Institute.

Editorial Note

General McNaughton's interesting comments are greatly appreciated, as is his valued contribution of the two maps to which he refers, and which have been received at Institute headquarters.

RIPPLE ROCK, B.C. (Canadian Developments)

The Engineering Journal, 1956, August, 1037.

F. G. Goodspeed, M.E.I.C.[1]

I was closely connected with the attempt to remove Ripple Rock in 1943-45, and was a member of the Research Council Board which recommended the method being undertaken at present. This method has been given consideration when the work was originally undertaken and was not suggested by a student at the University. Over the years it has been suggested by numerous people.

There is a fear that too much is expected from the 'removal' of Ripple Rock, which of course only entails the removal of that portion of the rock above the 40 foot depth at low tide. The reduction in tidal velocity will be infinitesimal and the whirlpool above the rock will still exist. Small vessels will have the same difficulty in navigating Seymour Narrows as they have at present.

No doubt the current velocity or the whirlpool, rather than the rock itself, have been responsible for a number of the deaths which have been attributed to the rock. These will continue to exist. During the former attempt to remove the pinnacle of the rock nine men were lost when their boat overturned in the swift current.

[1]Ottawa, Ontario.

DESIGN OF FROBISHER'S YUKON PROJECT

The Engineering Journal, 1956, September, p. 1183

Referring to page 1183 of September 1956 issue of the Engineering Journal, and in particular to the continuation on page 1324, we have the following comment:

J. M. Wardle, M.E.I.C.[2]

Page 1324, col. 3, para. 1: article two of the Boundary Waters Treaty of 1909 states that, ". . . each of the High Contracting Parties reserves the exclusive jurisdiction and control over the use and diversion, whether temporary or permanent, of all waters on its own side of the line which in their natural channels would flow across the boundary or into boundary waters . . ."

The treaty further states that "neither of the high contracting parties surrenders any right . . . to object to any . . . diversion of water, the effect of which would be productive of material injury to navigation interests on its side of the boundary." The effect of the latter clause was carefully considered in 1953 before any great expenditure was made on Yukon River investigations.

Meantime commercial navigation on the Yukon, both in Canada and the United States, has come practically to an end; also material injury can be remedied by storage reservoirs on Yukon tributaries. . . the only permission Northwest Power Industries must obtain is from the Dominion Government under the 1955 Act providing for control of structures and improvements on international waters.

Page 1324, col. 3, para 3: Grease Harbour was one of the sites examined in October 1955, but was found unsatisfactory and the site selected is 10 miles up-river from Grease Harbour.

[2]Consulting Engineer, Northwest Power Industries, Ltd.

Meeting the Shortage of Engineers and Scientists

(continued from page 32)

than just increasing the numbers of engineers and scientists.

Yet it is my firm personal conviction that these generalities will not suffice and, further, it is my conviction that each industry and each community will find attacks on these problems to be purely unique to that industry and to that community.

Engineers are by calling and training expert in analyzing problems, locating the essential and critical and basic questions, applying their peculiar knowledge in synthesizing possible solutions, and then finding that one best answer for the particular problem at hand. Yet when it comes to the peculiar problem of finding, stimulating, and educating our successors in our profession we have in general abdicated. We have washed our hands, saying isn't it too bad that our youth cannot or will not see what glorious opportunities lie ahead in engineering and science. We have left to the professional educationist —I don't want to call them "educators" —the preliminary education of our youth and the stimulation to consider engineering or science as a career. We have failed to place the dedicated teacher in a position of high stature within our community. We have taken halting steps to ensure that our engineering school staffs have opportunities to keep fully abreast of the advances in technology and to maintain those staffs in sufficient numbers. We do little to encourage or stimulate our engineering students to improve their creative abilities and to dedicate themselves to higher quality of engineering and science.

Let us stop "crying in our beer" and put our hearts and minds to work on the problems of improving our profession and improving its contributions to the society in which we live.

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

NATIONAL RESEARCH COUNCIL HIGH VOLTAGE SYMPOSIUM

A successful high voltage symposium, sponsored by the National Research Council of Canada, was held in Ottawa in September, 1956. Some 19 papers were presented by an international body of authors; the titles are given below.

Although abstracts of all the papers cannot be published here, because space is limited, copies of abstracts may be obtained on application to *The Engineering Journal.* The papers will not be available separately, but the National Research Council is going to publish all of them in one volume, which should be available early in 1957. There will be a small charge for this publication.

(1) Electrical Breakdown in High Vacuum; A. S. Denholm, National Research Laboratories, Ottawa.

(2) The Peculiarities of H. V. Cable Dielectrics; H. D. Short, Canada Wire and Cable Co., Ltd., Toronto.

(3) High Voltage Transformer Insulation Co-ordination; J. R. Meador, General Electric Company Ltd., Pittsfield, Mass.

(4) The Mechanism of the Electrical Breakdown of Triggered Spark Gaps of the Trigatron Type; P. K. Watson, formerly Nat. Res. Laboratories.

(5) A New Approach to the Calculation of the Lightning Performance of Transmission Lines; C. F. Wagner, Westinghouse Electric Corp., East Pittsburgh, Pa.

(6) Economics of Long Distance Power Transmission in Ontario; P. L. Dandeno and H. Teekman, Hydro-Electric Power Commission of Ontario.

(7) Problems of High Voltage Power Transmission; Ivar Herlitz, ASEA, Sweden.

(8) Limitations of A.C. Power Transmission; Ivar Herlitz, ASEA, Sweden.

(9) Characteristics of D.C. Transmission; Uno Lamm, ASEA, Sweden.

(10) High Voltage Measurements and Equipment — Surges on Transmission Lines and Stations; J. W. Skooglund, Westinghouse Electric Corp., East Pittsburgh, Pa.

(11) Impulse Voltage Measurement; F. C. Creed, Nat. Res. Laboratories.

(12) Measuring Steep-Front Impulse Voltages; H. Linck, H.E.P.C. of Ontario.

(13) Testing Insulators with Steep-Front Surges; H. M. Ellis, H.E.P.C. of Ontario.

(14) Impulse Failure Detection Methods in Transformer Testing; W. J. Purvis, Nat. Res. Laboratories.

(15) The Ultra Corona Discharge, A New Discharge Phenomenon Occurring on Thin Wires; C. A. E. Uhlig, Nat. Res. Laboratories.

(16) A.C. Corona Current and Losses on Thin Wires from Onset to Spark-over; C. A. E. Uhlig, Nat. Res. Laboratories.

(17) Factors Influencing the Corona Inception Voltage of Extra High Voltage Transmission Lines; G. K. Lambert, Northern Electric Company, Ltd., Lachine, Que.

(18) Corona Type Noise and Its Measurements; T. W. Liao, General Electric Company Ltd., Pittsfield, Mass.

(19) Radio Noise Testing of High Voltage Line Equipment; A. S. Denholm, Nat. Res. Laboratories.

THE IMPACT OF AUTOMATION ON SOCIETY

T. Burns, Senior Lecturer, Dept. of Social Study, University of Edinburgh.

Inst. Production Engineers Journal, 1956, October

Everybody who discusses automation is aware it is a word for developments as old as industry itself, yet there is an irresistible tendency to make it a crisis point. What are the social pressures making for this dramatization? Possible clues lie in the following:

(1) Occupational status has come to be the chief designation of social status.

(2) Outside the work-place differences in status as being reflected in clothes, activities, possessions, are becoming gilded. The traditional social structure is being overlaid by another structure of elite group and mass audience connected by mass communication industries.

(3) We remain a society dominated by the idea of success. Possibilities of success are being more and more restricted to educational and occupational promotions.

In discussing automation in the factory, what we are talking about are the changes likely to arise, or be needed, from an accelerated expansion of: *(a)* automatic machinery and transfer; *(b)* automatic process, product and quality control; *(c)* computer-controlled machinery; *(d)* rapid processing of information about costs, progress, stores, etc.; of these, the third is the most important.

There are certain changes which may be fairly safely counted on. These are:

(1) A large increase in the functions of programming, production, costing and planning operations.

(2) A considerable change in required skills and a much higher standard of competence.

(3) A considerable movement away from divisions of labour into individual, semi-autonomous jobs and towards interlocking service functions.

(4) A development of plant hiring schemes.

Present discussion about the social consequences of technical change hinges inevitably on technological unemployment. There is probably a considerable fluctuation in the demand of a particular industry or factory for individual skills, a fluctuation which would be wider than that in the total demand for labour. A factory will need a complement of craftsmen who could act as fitters, maintenance men, toolmakers, inspection controllers, at different times of the year.

Two possible consequences of automation, therefore, are a larger population of skills than of work people, and a heightened need for adaptability and mobility of labour.

Summarizing, the possible repercussions on people inside industry are: *(a) a much greater need for information, for people to collect and process it; (b) a need for workers with multiple skills; (c) a need for managers with more and more varied technical qualifications; (d) a need for more elaborate forms of programming; (e) a breakdown of traditional status divisions between management and workers.*

We are in for a period of considerable structural change in the social organization of industry. The system we live in has to be adjusted so that there is less discrepancy between the two. It must involve more fundamental reorganization of the roles of people at work and a recasting of the institutional structure of the workplace.

LET'S TAKE THE WASTE OUT OF STRUCTURAL DESIGN

Civil Engineering, 1956, Aug. 1, p.43.

Like all other professions, engineering can't always be reduced to a formula. The human factor looms large, and nowhere is it more in evidence than in structural design. This year a fortune will be spent in the study of building materials. But in spite of this many engineers will needlessly waste materials by over-designing their structures.

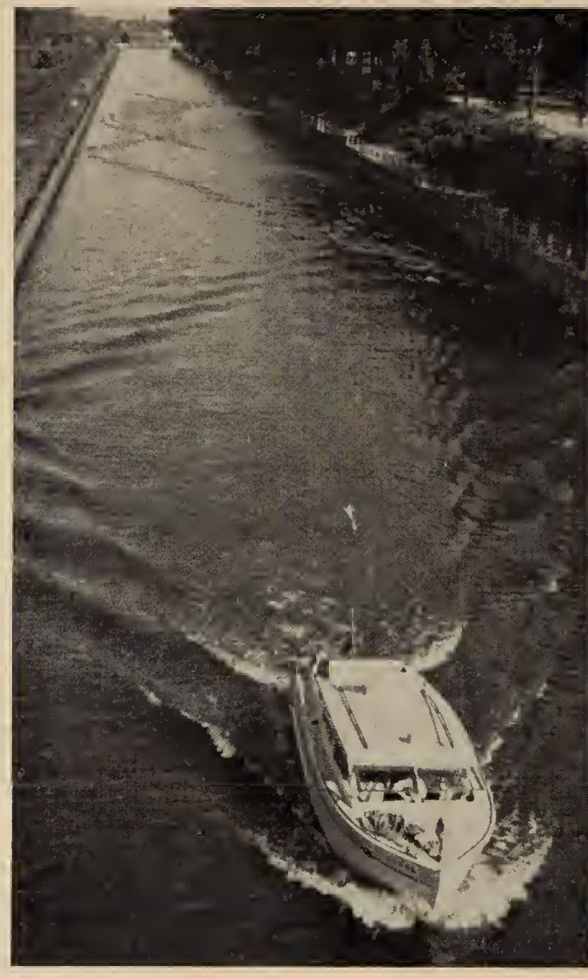
Because of the uncertainties to be found in most designs safety factors between 2.0 and 4.0 are commonly used. Sometimes these high factors are justified. But to overcome this all too-prevalent practice of overdesigning structures, the following suggestions are offered. Engineering societies should undertake two studies:

(1) First an appraisal should be made of existing knowledge. Second, case histories of thousands of existing structures should be studied. Reports of these findings would have a ready cash value among engineers.

(2) Technical and professional periodicals should feature more articles on economic designs.

(3) Engineers should continually endeavour to keep up to date on progress by reading the publications made available to them.

These suggestions, if followed, should lead to economical engineering. Let's take the guesswork out of design, with its resulting waste.



REFLECTED RIPPLES IN THE RIDEAU CANAL

This picture of the Rideau canal at Ottawa, taken from the Laurier Avenue bridge, near Union Station, shows an interesting pattern of ripples reflected by the vertical banks of the canal. The photographer, W. John Fletcher M.E.I.C., is prompted to wonder what factors determine the angle subtended by the two lines of the ripples—perhaps a member familiar with ship design would comment on this. (Taken on 35 mm. film, f8, 1/125 sec.)

ULTRASONIC TECHNIQUES IN INDUSTRIAL CLEANING

Dr. W. McCracken, Director of Research, Detrex Corp.

Inst. Production Engineers Journal, 1956, October

For several years, the use of ultrasonics in the fields of industrial application has been unduly exaggerated; wide areas of research still remain for development of practical and useful ultrasonic processes.

To understand the application of ultrasonics to industrial cleaning it is necessary to review the types of soil usually found on metal. This discussion is limited to soils such as grease and oil or grinding, polishing and drawing compounds and other organic or inorganic substances including finely divided adherent material known as smut.

The electro-strictive method using barium titanate as a transducer is the leading technique at the present time. A RF generator of some 400 kc/s. is required, with capacity varying from ½ kw. to 10 or more kw., pending on the application. For best results and maximum efficiency from ultrasonic energy, the technique must be employed as a tool in conjunction with a well designed cleaning process.

In summary, it can be said that the ultrasonic technique can, and is, being used as a powerful tool in the field of industrial cleaning; that it is best employed as the last stage of a well designed cleaning process; that it is adaptable to the process of solvent degreasing using chlorinated hydrocarbon solvents; that barium titanate transducers are far more adaptable than other types; that ultrasonic technique can, and is, being adapted to production line cleaning; and lastly that the best results are being obtained by ultrasonics in conjunction with solvent degreasing.

BRAKE ON A SATELLITE

Engineering, 1956, November 9

An electrical braking force, the existence of which has been proved by Dr. Bo Lehnert, of the Stockholm Polytechnical Institute, is likely to threaten the experiments with the satellites that are to be sent out into space during the International Geophysical Year 1957-58. The Swedish scientist's findings have led to an extensive correspondence with the American research workers who are planning the satellite programme.

According to the Swedish calculations the satellite will be electrically charged when bombarded by electrons and ions during its passage through the ionosphere. This charge will in itself have a retarding effect on the satellite—to what extent it is not possible to estimate at present—and also give rise to an electrically charged "wake" with unforeseeable effects on the satellite. The cautious wording of Dr. Lehnert's comments on the calculations runs: "Should it prove that the satellite does not behave in the manner foreseen, the electrical charge may offer part of the explanation to the deviation."

From Dr. Lehnert's correspondence with the American scientists it looks as if they had not previously paid attention to this phenomenon. The current research work at the Institution for Electronics of the Stockholm Polytechnical Institute has opened up many aspects related to this problem.

INTERCOMMUNICATION AND THE APPLICATION OF IDEAS

Civil Engineering, 1956, August, 60.

In spite of today's great engineering achievements, many signs indicate the recent past is only the beginning of an even greater engineering age. To support this volume of work with new methods and materials much research and development will be needed. The rate of progress in the arts and sciences of our profession will be a function of two dependent variables: efficiency of dissemination of basic research, and speed with which new useful development will flow from basic research.

Progress in achievement seems often dependent on accidental stumbling on right ideas when needed. Does this slow down our technical advancement, and what can we do about it? The primary purpose of this article is to provoke discussion so as to ascertain the extent of the problem and perhaps to start work towards resolving it.

We should establish a committee served by and answering to all engineering and scientific societies, to act as a central agency, whose functions should be to:

(1) Receive, summarize, and collate all new information.

(2) Distribute these to the proper technical groups.

(3) Maintain a board of experts for critical analysis.

Would the value of such an up-to-date indexed compilation outweigh the costs of such an organization? Can we afford not to do something along these lines?

THE DIDO TECHNIQUE FOR EFFECTIVE COMMUNICATION

Felton Koch, Prudential Insurance Co., Newark.

Advanced Management, 1956, October

All levels of management can be seriously handicapped by poorly transmitted communications, written or oral. Weak and badly interpreted information can bring about bad decisions and adversely affect company policy, administrative procedures and organization morale.

Define: You cannot communicate effectively when either talking or writing unless your words and symbols have established definitions known to you and your listener or reader.

Index: A custom of indexing clarifies and specifies references in communication. Practice indexing to develop the awareness of differences as a better way to understanding.

Date: Omitting time, degree, measurement, date, etc., often cause confusion or misunderstanding about the intention of the speaker or writer.

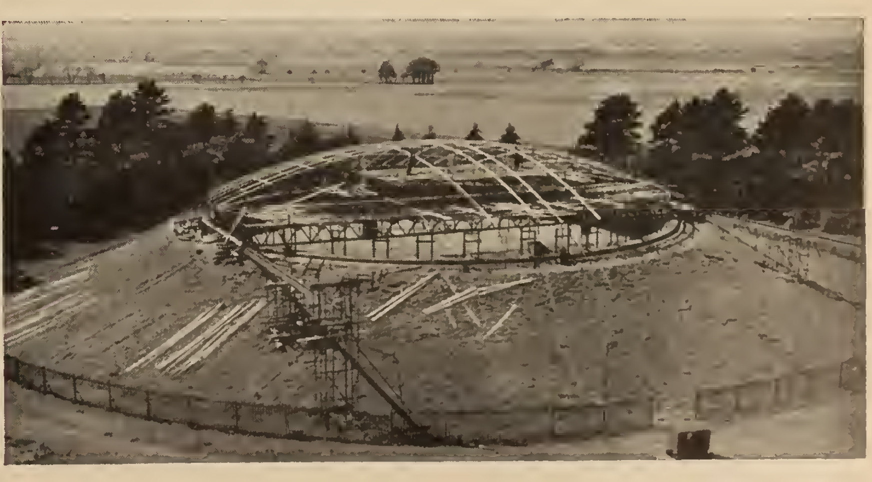
Orient: The purpose of communication consists of your attempt to convey a thought pattern from your mind to the mind of your listener or reader to turn off his mental 'record player' when he should have his 'mental recorder' operating.

If you want to communicate effectively, Define, Index, Date, and Orient your statements to eliminate semantic blockage. This method promotes understanding and agreement. If you use this formula you will create a style for your subordinates to follow, and it will improve the lines of communication in your company.

ROOF CONSTRUCTION FOR CIRCULAR RESERVOIRS

United Kingdom Information Service

New reservoirs for immediate supplies of filtered water for communities are now generally roofed over to prevent pollution by airborne impurities. Traditional roofing methods often use support columns from the reservoir floor, which entails draining during construction and other difficulties such as added risk of contamination. One answer to the problems, for new or old reservoirs, is the use of self-supporting domed aluminum roofs, of which two examples have recently been installed, without draining, in Bedfordshire, England. These are shallow spherical domes consisting of a grid of box-section ribs located on two series of great circles; they are clad with flat 16 S.W.G. aluminum alloy sheet.



RESPONSIBILITIES OF THE ENGINEER EMPLOYER

H. Weirsema, M.ASCE., Assistant Chief Engineer, Tennessee Valley Authority

Civil Engineering, 1956, October

From 13 years of experience in collective bargaining with employees in T.V.A., and from observation of the experience of others, the author has come to certain conclusions:

Professional societies have had little influence on employee relationships, and this little has had small effect on raising the economic status of engineers.

The employer no longer has the personal contact necessary for complete understanding. Because of this lack of personal influence, young engineers in increasing numbers have joined unions with the hope of national benefit — such unions have helped increase the salaries of engineers to raise their economic status.

There is not necessarily any irreconcilable conflict between the professional status of engineers and the efforts of unions to improve their economic status. Whether we like it or not, we are going to see more rather than less unionization of engineers in the coming years. Any amount of persuasion and discouragement of unionization will be ineffective in the future. Instead of worrying about employee unions the employer should be working for better economic status for his employees.

As a result of his experience with younger engineers, the author is certain they will respond to the efforts of their employers to improve their professional status.

SPACE HEATING WITH THE ATOM (USE OF WASTE ENERGY)

S. L. Nelson,

General Electric Review, 1956, November

Getting motive power from the atom claims so much attention that engineers and scientists overlook one important potential; utilizing raw energy as it comes from the atom nucleus in the form of heat.

For ten years Hanford engineers watched tremendous amounts of heat energy literally go down the drain. Because the reactors were built to produce plutonium, heat energy became a troublesome by-product requiring the simplest possible method of disposal. So it was dumped back into the Columbia river after allowing time for decay of radioactivity induced by neutron bombardment of the water molecules passing through the reactor cooling tubes.

The paradox of running hot water into the river while burning coal to heat buildings challenged G.E. engineers. With the T. C. Main Company, of Boston, they pioneered in the design of a space heating system. The main components are: (1) an outdoor central exchanger to extract heat from water after it has passed the reactor; (2) a mixture of ethylene glycol and water, heated in the central heat exchanger; and (3) a distribution system to circulate the ethylene glycol through the radiating coils and exchangers used to heat the plant buildings.

The significance of the atomic furnace lies in its wide potential application and relative simplicity in design. This does not mean that in 10 or 20 years smokeless atomic furnaces will replace combustion furnaces. It does mean the use of atomic energy for heating large hotels, office buildings and other compact areas with large space heating requirements is feasible now. Though not enough work has been done on all the economic aspects of atomic space heating to make any evaluation, the AEC has already laid the groundwork for standardization and control. Details of the design are given.

THE MEASURE OF AIR POWER

Canadian Aviation, 1956, October

A revolution in air arms! That's the measure of achievement by the aircraft industry in the United States during the 1950's.

Some seven years after the first successful jet flights, the bulk of U.S. air power was still built around the piston engine. After World War II production, employment dropped from over a million to about 235,000. With the exception of a few projects, research and development was similarly stymied.

In June 1950, U.S. Air Force combat strength consisted of 47 wings. Equipment was mainly piston driven aircraft. The Navy's situation was comparable. By mid-1957, the Air Force will have reached its goal of 137 wings, all flying the latest production aircraft suited to their role —the vast majority of them jets. Naval air power now consists of 17 similarly well-equipped air groups plus three Marine Air Corps wings.

The next really major task already underway, will be re-equipment of commercial carriers with the latest jet equipment. The end of the crash program has undoubtedly sharpened competition.

Commercial airplane orders on the books of American aircraft manufacturers now stand at an all-time high figure. The horizon of accomplishment continues to widen with each new advance. There is no doubt that aviation's greatest years still lie ahead. Achievements of the American rocket industry over the past decade have been previously unequalled. They will be mild in comparison with what will be accomplished in the next decade.

Canadian Aviation contacted officials of leading American companies for their frank appraisal of conditions in the U.S. aviation industry and an evaluation of the prospects for their individual firms. Some 17 of these interviews are given in condensed form.

GAS LUBRICATED BEARINGS

Engineering, 1956, November 2

Gas lubrication, which has recently undergone considerable development under the stimulus of the atomic energy programme, may well have applications to half a dozen other branches of engineering, and this is borne in mind by the authors of a paper "Principles and Applications of Hydrodynamic-Type Gas Bearings", presented at the Institution of Mechanical Engineers on October 26. The authors, G. W. K. Ford, M.B.E., D. M. Harris, and D. Pantall, are all members of the United Kingdom Atomic Energy Authority. The call for gas bearings arose from the need to install moving parts within enclosed gas circuits where contamination of the gas is undesirable, the parts themselves are largely inaccessible and the formation of oxide films is impossible; this occurs in gas-cooled reactors such as those at Calder Hall. In addition, pumps for liquid metals, which may be at high temperatures, require a lubricant that does not deteriorate under the action of heat and will not contaminate the metals being pumped; bismuth, which may serve as a solvent for nuclear fuels in future reactors, is chosen by the authors as an example. However, high temperatures, gas circuits, inaccessibility, particulate matter in suspension, and the need to exclude contaminating materials are requirements not unique to atomic engineering. To place gas bearings in the context of other applications, the authors outline their features and limitations, and name some other fields of engineering — machine tools and chemical industry for example — in which they may be used. The paper is concerned mainly with hydrodynamic as distinct from hydrostatic bearings and covers both thrust and journal types.

THE RUSSIAN EXAMPLE

The Times Science Review, Winter, 1956

Science is international, but also competitive. It is international by necessity, as well as tradition; it depends for its progress on the exchange of knowledge and ideas, without restriction from language race or culture. The course of exchange between the Soviet Union and the West has been more free during the past year than for a long time. As Professor P. B. Moon, F.R.S. wrote: "From ignorance of Russian work, we are swinging through rivalry to possible cooperation." The ideal of cooperation in research is indeed worthy. But it is the competitive element which, in Britain, needs most to be emphasized. And the competition which matters is not that between one scientist, or one laboratory, and another, but between nations.

Science, for most working scientists, is an end in itself. It is also the foundation on which most material progress is based. The need for scientists and engineers has been realized from the start in the Soviet Union. The pace set was a hot one, and the emphasis was on quantity to begin with. The fact that quality was being achieved also, at least in the physical sciences, has penetrated only slowly to outsiders.

There has been evidence, and to spare, of progress. Much, admittedly, has been imitative — for example, in methods of building dams on alluvial rivers, and in the early development of jet aircraft — but much also has been independent. In one field, that of atomic energy, the preparatory meetings for the Geneva conference of August, 1955 led to the beginnings of reassessment. The process was accelerated and completed at the conference proper. The quality — and independence — of much of the Russian work was perforce recognized. But it was still a

A Guide for Authors

Authors of articles for publication in *The Engineering Journal* should be guided by the following notes.

MANUSCRIPT

Two copies are required, double-spaced, typewritten on one side of 8½ x 11 in. paper, with a wide margin (1½ in.). Author's name, professional affiliation, and a 100-word summary of the paper should be given on a separate sheet.

References

Superior reference figures are used; e.g. . . . Artz[3]

References and bibliography are collected at the end of the paper. The style used is: author, title, publication (abbreviated), volume no., page; e.g.,

[3]Artz, M. Frequency Modulation of RC Oscillators; *Proc. I.E.E.*, 1944, vol. 32, 409.

Mathematical Work

Complex formulae should be hand-printed unless a special typewriter is available. The relative positions and sizes of symbols must be distinguished (e.g., between Eo and EO, E_2 and E^2).

Identify any special symbols (e.g. Greek letters). Keep mathematical work and equations separate from the main text as far as possible — e.g. numbered in a separate appendix.

Abbreviations

The practice followed is that of the Canadian Government Style Manual. Most abbreviations are in lower case with periods (m.p.h., kv., kwh.); singular and plural the same (12 lb., 20 in.).

ILLUSTRATIONS

These notes are a general guide; the editorial staff will be glad to give more detailed advice on preparing illustrations.

Photographs

Glossy prints, preferably 10 x 8 in.; not less than 5 in. on longest dimension.

Diagrams

Black ink on white paper or tracing cloth; not more than 12 x 16 in. Usual *Engineering Journal* size for cuts is 4½ in. or 6¾ in. wide; original lettering must be big enough to appear not less than 1/16 in. high after reduction.

All diagrams, particularly maps and scale drawings, must be simplified to essentials. Graphs must not be drawn on "graph paper", but with the fewest necessary cross-lines (not more than 8 lines per inch after reduction). The weight of the finest line, after reduction, should be not less than a clear typescript letter 1.

Blueprints, coloured diagrams and pictures, and diagrams with solid tints or shading are not accepted for publication.

Legends (captions)

Figures and tables should be identified (Fig. 1, 2, etc.; Table I, II, etc.) and relevant legends listed on a separate sheet.

surprise to most British physicists to learn from Academician I. V. Kurchatov, in July 1956, of the scale and excellence of the research done in Russia on the approach, by one particular method, to the realization of the high temperatures needed to bring about thermonuclear, or fusion, reactions under controlled conditions in a laboratory. The investigation so fully prosecuted must have been done in the main for its own sake; in relation to its primary object, it must have been virtually written off at an early stage.

In the meantime there had been visits by British and American scientists to Moscow. These were not the first; but most of the earlier visitors had been enthusiasts, sometimes uncritical in their reports. Now a more general impression was possible. To travellers' tales and the information that the Soviet Academy of Science employed more than 10,000 scientists of university standard in roughly 100 research institutes, it could be added that laboratories and teaching facilities had been viewed by relevant specialists and that especially in the physical sciences they had come away greatly impressed. That is not to say that all Russian work is good, or even that the average of it is as high as, for example, in Britain. Nor has Russia yet more scientists and engineers than the United States. But the output of trained men is greater, equipment lavish, opportunities for research wide, and the volume of good work substantial and growing.

Among these organized visitors to Russia were delegates to a conference on high-energy nuclear physics, held in Moscow; they visited the Institute of Nuclear Studies at Bolshoya Volga. (The issue contains an illustrated article on this Institute.) The impression is, again, one of size, energy and determination to push ahead. They have built the largest nuclear accelerator of one kind, then of another, and now are planning a third. They are also very ready to discuss — much more so than in the period of building up and preparation. The stage, as it were, has been set, and criticism of the production can be invited freely. It is not longer necessary, as in the past, to rely on the making of dubious claims to priority. The impression should be as much stimulating as alarming.

In nuclear physics, especially, Britain has a unique record in discovery and, even since the war, has made a surprisingly big proportion of contributions. In the application of discovery she can point to the Calder Hall nuclear power station. But in the training of scientists and engineers there has been more of lip service than performance. There has been a lack of appeal in schools, and later, to many who, with more of encouragement and interest, might have been among the best material available. There has been a lack of incentives — in Government departments, in teaching, even in some sections of industry. There has been too much talk about the best means of expanding technological education at the higher levels, too little done. It is time that the lesson of Soviet progress was learnt. If Britain is to survive in a world which year by year becomes technologically more competitive, it must be learnt soon.

FRANCE MOVES FORWARD

An illustrated booklet, entitled France Moves Forward, describes the economic and technical progress made in the French Union in the years 1946 to 1955. Atomic power, the coal and steel industries, hydro-electric power and hydraulics, and thermal power are among the subjects covered. Advances have been made in transportation by land, sea, and air; in metals and their fabrication; and in petroleum. French achievements in several fields overseas are also described.

Co-Operative Research in the British Electrical Industry *(continued from page 23)*

issued. Technical enquiries are answered by reference to the Bureau's own classified data, an expert on the technical staff or an extra-mural associate. There is a weekly abstract service and loans of periodicals and books to members have risen to over 4,000 a year. The Technical Liaison Department is responsible in general for guarding the interests of members. It organizes personal visits for discussion with a view to ascertaining the problems which arise in industry where the E.R.A. can be of assistance, and bringing these problems to the attention of the departments or committees concerned. It also organizes informal meetings to which representatives of members are invited for the discussion of specific fields of research which are ripe for industrial application. The endeavour is always to establish a personal link which will go further than that which can be achieved by the normal issue of reports. A further step which has recently been taken in this direction is the issue of a house journal comprising articles on general and specific subjects related to the work of the Association, designed particularly to appeal to directors and others who are in a position to make the fullest use of the results of the E.R.A.'s researches.

Acknowledgments

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* Paper read before the British Electrical Power Convention, June, 1952.

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Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

The weather continued generally favourable for construction work throughout the month, and good progress was made.

Progress By Ontario Hydro

The total work force in the Ontario Hydro section was 4,100 persons.

Work began during November on removal of Iroquois Point, one of the major channel improvement contracts. An excellent start was made on this contract with approximately 45,000 cubic yards of material removed and placed in the temporary cofferdam. This cofferdam will act as a dividing dike between Iroquois control dam and the seaway work at Iroquois Point.

At Galop Island, the south dike was extended east to Dixon and Kellogs Islands. The north cofferdam had been extended. Excavation on the west end of Galop Island proceeded well. Earth removal to date has amounted to 7,350,000 cubic yards, and rock excavation to month end amounted to 500,000 cubic yards.

At the power-house site, splendid progress was made in concrete placing operations. By the end of November a total of 370,000 cubic yards of concrete had been placed, or 40 per cent. Five draught tubes had been poured and two more started. Mechanical parts were being installed. The draught tube liner was installed in unit No. 2 and work was well advanced on the installation of the speedring.

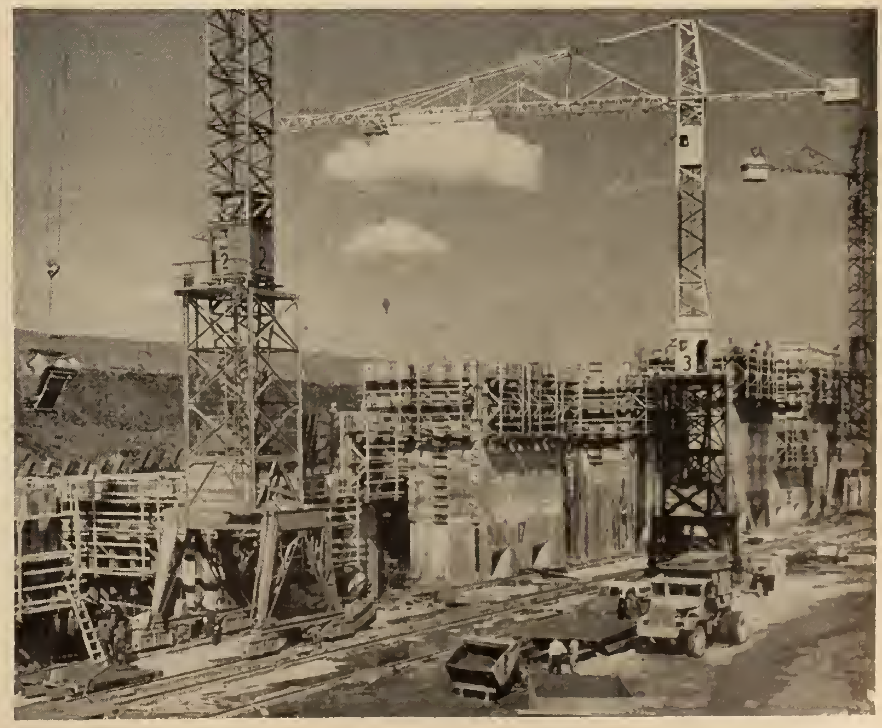
The concrete walls of the Cornwall diversion canal closure structure were finished during the month. Approximately 75 per cent of the excavation of the mile-long diversion canal had been done by the end of November.

Till placing and compacting on Cornwall dike was terminated in mid-November. Only the granular course on the top and the rip rap on the slopes remains to be done in section 3. Approximately 55 per cent of the till in section 2 had been placed and compacted and that work had also ceased for the season. All stripping had been completed in section 1.

On the C.N.R. relocation, work on grading contracts was completed early in the month. All the double track had been laid for the entire 40 miles and about 75 per cent of the ballast had been placed. Work was in progress installing telegraph equipment and block signals.

Concrete footings had been com-

Cote Ste. Catherine lock in the Lachine Section. Three gantry cranes of French design are being used. Placing of monoliths for about one-half of the photographed side of the lock was complete, and work was being done on the opposite side also. Filling and emptying ports and culverts can be seen.



The high level suspension bridge over the south channel of the St. Lawrence River from the U.S. mainland at Massena, to Cornwall Island, is to be ready for traffic on November 30, 1958. Contracts were awarded recently to The American Bridge Division of United States Steel Corporation for the superstructure on their bid of $4,759,045; and to McNamara Construction Company, Ltd., Toronto, for the substructure, at $1,240,550. D. B. Steinman, M.E.I.C., of New York prepared the design and specifications. The cost of the bridge will be shared by Canada and the United States, with SLSDC administering the superstructure contract, and the SLSA in charge of the contract for the substructure.

pleted for the 1957 phase of the St. Lawrence transformer station construction. The second relay building, scheduled for completion next year, was virtually completed.

House moving operations began in new town No. 1 (Ingleside) in November and eight houses were moved. Already the water lines and sewers had been completed and the subgrade for the entire road pattern was finished. Construction continued on the Roman Catholic church and the public school. Footings and walls for the shopping centre were being constructed. The water pumping station and sewage pumping station both were in operation, while the sewage plant was nearly finished.

At new town No. 2 (Long Sault), all major house moving operations were completed. A total of 106 houses had been relocated. Building of the shopping centre was started during the month. Footings for the water tower were completed and the sewage treatment plant was under way.

Sewer and water lines were completed for the new sub-division at Morrisburg. Basements were under construction for 30 homes and a limited house moving program is underway. At Iroquois, main activity was on the shopping centre, the high school, public school, the Presbyterian and Roman Catholic Churches.

Progress by NYSPA

November progress was underscored by the release of water into the completed Stage 1 of Long Sault dam, with 20 per cent of the river flow passing through at month's end. Overall construction passed the halfway mark as concrete placement to date exceeded 900,000 cubic yards and excavation for all features exceeded 31 million cubic yards. Employment averaged 4,450 for the month.

At Long Sault dam, excavation of the river bed above the dam and erection of the upper sections of the spillway gates were completed. The removal of the sheet steel piling was continued from the Stage 1 cofferdams. Excavation of Cut "F" progressed to 90 per cent of completion and seeding of spoil areas was started. Placing of rockfill for cofferdam "E" was resumed.

Concrete placement in Barnhart Island power-house increased the total placed to 430,000 cubic yards, or nearly half the total. Intakes on two units were poured to the top. Eight draught tubes were poured and stripped and some concrete placed on all 16, with some completed. Excavation for the switchyard equipment foundations and concrete placement for the various structures was continued. Embankment work for the south forebay dike had been discontinued for the season, and concrete operations will be closed down by Christmas for the winter.

At Iroquois dam, twenty-three of the forty stage 2 cofferdam cells had been placed. Removal of the upstream and downstream stage 1 cofferdams was in progress. 75 per cent of the river flow was passing through stage 1 at the month-end.

All stage 1 concrete for Massena intake had been placed. Excavation for the channel upstream and downstream of the structure continued and stage 2 cofferdam cells were being placed. Work on the temporary water line upstream from the structure was in progress. Excavation under the five channel improvement contracts had passed the half way mark. Seeding and mulching of the Red Mills Point spoil area was completed. Work was in progress on the three reservoir clearing contracts between Waddington and the St. Lawrence power dam. Cleaning of the reservoir as a whole was approximately 25 per cent completed. Clearing and chemical treatment of the Barnhart-Plattsburgh transmission line right-of-way was progressing. Continued progress was made on the rehabilitation of the Massena-Taylorville transmission line.

Production of construction drawings continued at a high rate. Much effort has been put into expediting various equipment items to insure their arrival on the project in time to avoid any delays in the tight construction schedule.

Progress by SLSA

Progress on construction of the seaway this summer and fall has been good, and is marked by the completion of several contracts and a change in emphasis from excavation to the building of structures, announced SLSA president Lionel Chevrier on November 20. All general contracts in the Lachine, Soulanges and Lake St. Francis sections had been awarded, as well as most of the contracts for bridges and lock equipment. Still to be awarded were one contract for dredging approaches to the Iroquois canal and lock, and two dredging contracts for deepening of the Welland Ship canal.

The overall progress as of the end

of October showed 30 million cubic yards of excavation completed out of a total of 65 million, or 46 per cent; 5½ million cubic yards of dike construction completed out of a total of 9 million, or 60 per cent; 250,000 cubic yards of concrete had been placed out of a total of 1,800,000, or 15 per cent, he stated. During the peak of activity this year a total of nearly 4,000 men were employed by the contractors on the construction of Canadian locks, channels and bridges. At the end of November construction and equipment contracts to a value of some $178 million had been awarded by Canada's Seaway Authority.

During the summer contractors began placing concrete at Canadian locks, and by year's end substantial quantities of concrete would be placed. Excavation work should be largely complete a year from now, and next year and 1958 would be generally devoted to the completion of concrete work, installation of lock gates and equipment, erection of equipment, and erection of bridges. There was little visible sign as yet of bridge construction, but various steel mills were producing the steel, while steel fabricating firms were preparing the steel work and planning for erecting the bridges and lock equipment at the sites.

Lachine Section

Work in the Lachine section was covered by 12 general contracts worth 65 million dollars, explained Mr. Chevrier. These included contracts for the two locks at St. Lambert and Côte Ste. Catherine, eight contracts for 16 miles of channel excavation and dike construction from below Jacques Cartier bridge to Lake St. Louis, and two contracts for dredging at the Montreal harbour approach and in Lake St. Louis.

Other contracts had been let for raising of Jacques Cartier bridge, for lift spans at Victoria bridge, for the first stages of the new high level approaches to Honoré Mercier bridge, and for the lift spans at the Canadian Pacific Railway bridge at Caughnawaga. Contracts had also been awarded for most of the lock equipment, gates, fenders, valves, machinery and other items.

Construction was actively under way on Lachine section general contracts from deep water in Montreal harbour to deep water in Lake St. Louis, a distance of 20 miles. Dredging of the Montreal harbour approach to the seaway channel was on schedule. The first stage of the work for raising the Jacques Cartier bridge was almost complete.

Progress on the two contracts for channel and dike from Montreal harbour up to Victoria bridge had been good, said Mr. Chevrier. Construction of St. Lambert lock and the sub-structure work for the modifications to Victoria bridge were making good progress. First concrete was placed in the lock structure in May and about a third of the south wall had been completed. Concrete was also being placed for the downstream entrance wall.

Excavation of the channel and construction of dike for the seven-mile stretch around Laprairie Basin to Côte Ste. Catherine lock was showing good progress. The work was being done in two contracts and both would be approximately half completed by the end of the year. At Côte Ste. Catherine lock excellent work by the contractor had resulted in this work being close to scheduled status. At the end of November concrete for the north lock wall had been almost completed and a good start made on the south wall.

Immediately upstream of the lock the first completed major contract was finished last February, for excavation of the channel and construction of dike for some three-quarters of a mile, overland. Next upstream was three miles of channel excavation and dike construction involving a total of 7½ million cubic yards of excavation. Progress had been maintained at scheduled rates.

Contracts had been awarded for work in connection with the extension southward of the Honoré Mercier bridge and with highway work involved in this. A clearance of 120 feet overhead at bridges had to be provided for vessels. At the C.P.R. Caughnawaga bridge, lift spans would be provided.

Work was being done in two contracts to provide the channel from below Honoré Mercier bridge to the Lake St. Louis entrance, upstream.

The St. Lawrence Seaway Authority inaugurated its Hydraulic Laboratories at Ville LaSalle, Que., on December 13. The object of the models already housed in these laboratories is to prove mathematically by tests the effect of works in the Lachine Section. Part of the Lachine Rapids model is shown below; another one reproduces the conditions to be dealt with in Montreal harbour; they were built by Neyrpic Canada Limited. The Authority has models of other important parts of the seaway in laboratories at the National Research Council.

All steps had to be planned to avoid interference with rail or highway traffic. The channel will skirt the river shore in front of Caughnawaga village for about two miles. Here two miles of cofferdam were being constructed in fast water in the river parallel to the shore, of which about 60 per cent had been completed. The dredging of the channel in Lake St. Louis was ahead of schedule.

Soulanges and Lake St. Francis

Work in the Soulanges section was covered in four general contracts valued at some $32 million, Mr. Chevrier reported. These included the lower and upper Beauharnois locks, a large part of preliminary excavation work and cofferdam construction, and a contract for crushing excavated rock for aggregates. Others would be let for a railway swing bridge for the New York Central Railroad across the upper Beauharnois lock, a lift bridge at St. Louis for combined highway and rail traffic. and a lift bridge at Valleyfield for combined highways and rail traffic.

At Beauharnois, the three general contractors were actively excavating rock at a combined rate of 10,000 cubic yards of solid rock per day. Excavation for the highway tunnel under the upper entrance to the lower lock had been completed, and the construction of the concrete tunnel was just getting started.

Work in the Lake St. Francis section had been covered in three dredging contracts totalling some 4½ million cubic yards valued at some $6 million. This work was now more than 60 per cent complete.

International Rapids Section

Improvements in the Cornwall Island channels would be done soon and a contract would also be let for the substructure of new high level highway bridge from the U.S. mainland to Cornwall Island.

The contract for the lock and canal at Iroquois Point had been the first lock contract to be awarded, and was the first on the schedule for completion. Early completion was a necessary factor in the coordinated development of the upper part of the river by power and seaway entities. A large and deep excavation across Iroquois Point had to be made before much could be done on construction of the lock or its entrance walls. Over 3½ million cubic yards of material had been excavated, and the concrete structure to date had 100,000 cubic yards of concrete placed. This work would continue during the winter. Start of erection of the lock equipment at Iroquois was planned for January 1957.

Welland Ship Canal

In this section, three contracts were awarded for excavation in the dry. This work is to be completed during the winter seasons of 1956 and 1957, while navigation is closed. One contract had been awarded in the Port Colborne area for dredging part of the canal from 25 to 27 feet. There remained a contract to dredge the entrance to the canal from Lake Ontario, to be let shortly. No other work was required in this section, since all the locks are of the dimensions approved for the new locks under construction in Canada and on the United States side in the International Rapids section.

Contract Awards by SLSA

The Russell Construction Co. Ltd., of Toronto, was awarded a contract on November 20 for dredging, and guard gate to station 710, Welland ship canal, at a price of $7,280,575. Other contracts awarded during November included one for supply and installation of Taintor lock valves at all locks and Taintor regulating valves at upper Beauharnois lock, to Bridge and Tank Co. Ltd., Hamilton, Ont., at $773,660; and another for lighting standards and lighting units for lighting the locks and canal prisms of the seaway, to Canadian Westinghouse, Montreal, at a price of $145,997.

The contract awarded to Russell Construction Co. was the first major contract awarded by SLSA to a British-owned firm, and was signed by Sir Andrew McTaggart, president of Balfour Beatty and Co. (Canada), and chairman of the British firm Balfour Beatty and Co., and by A. B. Sharp, president of Russell Construction Co., a wholly-owned subsidiary.

Dredging Controversy

The deadlock concerning the dredging in the International Rapids section for the channel on the north side of Cornwall Island may soon be resolved. An exchange of notes between the United States and Canadian governments appears to be clearing the way.

Dredging of the seaway channel south of Cornwall Island increases the flow from 66 per cent to 80 per cent, contrary to provisions of the Boundary Waters Treaty. Canada claims right to dredge a 27-ft. channel north of the island from Lake St. Francis to Cornwall, to restore the natural balance of flow. The United States has objected to this, fearing a duplicate seaway channel on the Canadian side would result.

Meantime the two seaway authorities, wanting to get on with the construction, worked out a plan to divide the cost of all this dredging on a 50/50 basis of $17 millions each, less $6 million credits to each from Hydro and NYSPA, and a start was made in October on work at the two extreme ends, avoiding the areas of acute controversy.

Jacques Cartier Bridge

Work was started the last week of November on the raising of Jacques Cartier Bridge to provide the required 120 foot clearance above the ship channel. The two piers on either side of the channel have to be raised fifty feet and an inclined roadway built on either side.

Progress By SLSDC

At the end of November, excavation on the upstream part of Long Sault channel over the islands was 95 per cent complete; section over the mainland 45 per cent complete and excavation for the two locks 65 per cent complete. The dikes at Richards Landing, Long Sault canal, Eisenhower lock, south forebay and Long Sault dam were 60, 70, 90, 70 and 15 per cent completed, respectively.

Concrete for the Eisenhower lock was 45 per cent done, with 240,000 cubic yards in place. The south lock wall was built to 2/3 of its height for full length and the north wall to half height for part of its length. Concrete for the Grass River lock with 220,000 cubic yards placed, was 40 per cent completed; most of the work done was in the lock structure, with both walls built to half their height. Placing of concrete was discontinued in November for both locks, but digging on the navigation channel will continue through part of the winter season.

Canadian Pipeline Projects

Westcoast Transmission

More than 407 miles of pipe had been welded on Westcoast's 650-mile main line by mid-November. Good progress was being made all along the line, in spite of early winter sleet and snow in some parts of the interior. On spread No. 1 in the north, Dutton-Williams Brothers had welded 86 miles. Bechtel Construction Division, responsible for spread 2, had welded 143 miles. Conyes Construction Corporation had welded 114 miles; and Mannix Limited, spread No. 4 on the south end, had welded 64 miles.

More than 490 miles of 30-inch pipe had been received. Pipe was being delivered at the rate of 20 miles a month, and it is expected deliveries will be completed by July, 1957. Shipments received during the winter will be stockpiled at strategic points along the line in preparation for the 1957 construction season. Pipe for the gathering lines was being received and stockpiled. Meanwhile, the completed sections were being tested. More than 7 million tons of earth and rock must be handled on the 650 miles of main line alone.

One of the trunk lines of the gathering system near Fort St. John, consisting of eight miles of 18-inch pipe, and grading of other portions of the gathering system, was well under way. Fifty miles had been graded. Full-scale pipelining on the gathering system starts in the spring. Work was moving forward on three compressor stations; at Taylor Flats in the Peace River Block; and near Quesnel. Foundations were between 60 and 70 per cent complete. Work on the stations will continue throughout the winter.

There are 13 crossings on the main line over navigable waters, seven of them submarine crossings and the others aerial. Construction of the first crossing of the Peace River at Taylor Flats was virtually complete, with foundations, bridge structure, towers and cables in readiness for pipe, which will be installed next year. The Fraser crossing at Shelley, near Prince George, was 98 per cent complete, with pipe installation 70 per cent complete. Crews on the Quesnel River crossing near Quesnel had erected towers and were stringing bridge cables.

The Huntingdon meter station had been completed, except for paint. This station is in reality two stations in one. There is equipment for metering gas for B.C. Electric, and one for Pacific Northwest. The equipment is designed to meter gas in either direction. Gas is now flowing from south to north, and upon the completion of the Westcoast Transmission line, the flow will be from north to south.

B.C. Electric Gets Natural Gas

Mid-November saw the first flow of New Mexico gas trickling across the British Columbia border to serve the B.C. Electric's Vancouver distribution system. The company spent $10 million in 1956 to lay its 36-mile pipeline from Huntington to a gas terminal at Patullo bridge, and for revising and expanding many of its distribution lines in the metropolitan area. It was also spending another $3 million to convert gas appliances already in use from manufactured to natural gas. Total company expenditures on natural gas will reach $30 million.

A fever of gas-furnace installations had hit Vancouver, with the Company's services pressed to keep up with demand. Spurring it was the increasing scarcity of supplies of sawdust for furnaces using "hog-fuel", during winter months. Faced thus with a possible serious gas shortage, home owners were being advised to keep their oil burners for the time being.

The company had successfully applied to the Federal Power Commission through its temporary supply source, Pacific Northwest Pipeline Corp., for an additional 20 million cubic feet per day, in addition to the 12 million feet daily originally contracted for. The FPC was quick to grant its permission to Pacific Northwest for this additional temporary export.

Financing for Inland Gas

Early November saw the offering of 250,000 shares of 5%, $20 par cumulative redeemable preferred stock of Inland Natural Gas at $17.50 a share, or a total of $4,375,000. Each share carries one warrant for one share at $7.25 after March 1, 1957. Proceeds will go towards building the Company's distribution system. Further financing will be needed later for the company's program which will cost a total of close to $25 million.

Inland has announced its rates will be approximately the same as those for major B.C. coast centres served by Westcoast. These rates are expected to spur industry and improve living conditions over a large area in interior British Columbia.

El Paso to Buy Pacific Northwest System

Canadian gas is seen gaining almost continent - wide distribution through the recent proposal of El Paso Natural Gas Co. to acquire the Pacific Northwest Pipeline System. As a result of the record expansion and development program this year in British Columbia and the Peace River area of Alberta, reserves have expanded very rapidly and government and gas company officials are seeking greater market outlets.

If and when FPC approval of the deal is forthcoming, Pacific Northwest will mesh perfectly with El Paso operations. When the flow of gas is reversed southward in about seven years time Canada will be the major source of gas for California, supplemented by San Juan reserves.

Trans Canada Pipelines

By Mid-November, Trans Canada had awarded a contract for the 98½-mile fifth section between Miniota river crossing and mile 498.3 just north of McGregor, to Price-Poole Construction, Ltd. This contractor had set up a field office at Brandon, and had started on clearing and grading. No pipe laying will be started until spring.

By late November a contract had also been awarded for the 86 miles of section six betweeen McGregor and the east side of the Red River, exclusive of the river crossing east of St. Norbert, to Canadian Bechtel, Ltd. The contractor was setting up a jointing yard two miles east of Portage la Prairie and planned to clear and level the right of way this winter, possibly do some double-jointing and stringing as well.

Dunn Brothers of Dallas will string for Price-Poole, while Universal and Canadian Bechtel will do their own stringing. Some 13 miles of pipe had been delivered at Portage la Prairie and some at Oakshela.

Work was still proceeding on Universal, Dutton-Williams and Price-Poole spreads, while some 230 miles of pipe on spreads one and two had been welded and 220 laid in the ground.

Sites had been chosen for compressor stations, one at Ile des Chênes where the 34-inch pipe terminates, and the other just west of the Portage la Prairie crossing of the Assiniboine river. One of the dual 34-inch pipes 2600 feet in length had been pulled across the Assiniboine near Miniota, soon to be followed by the second pipe. Dual crossings of the same river will also be made near Portage la Prairie at an early date by the same contractor, Marine Pipeline and Dredging Ltd., of Vancouver.

Estimated First and Fifth Year Deliveries

Latest estimate of expected deliveries of natural gas to areas along the Trans-Canada route, in billions of cubic feet yearly the first and fifth years of full operation, respectively, are as follows: Moosomin to Swift Current, 4 and 4; Brandon to Portage, 3 and 5½; Greater Winnipeg, 7 and 14; Keewatin to Lakehead, 7 and 10; Lakehead to Toronto, 13 and 26; Toronto (Consumers Gas Franchise area), 24 and 48; Southern Ontario (Union, United and Dominion), 16½ and 28; Ottawa-Hull, 10 and 12; Toronto to Montreal, 4 and 7; Metropolitan Montreal, 15 and 42. Totals, 103 and 196½ billion cubic feet.

Trans Canada is reported to have recently signed a 20-year sales contract with a newly formed company, Provincial Gas and Northern Quebec, Ltd. Some $4 million may be spent to pipe the gas to Rouyn, Que., and other areas near the Ontario-Quebec border.

Alberta Gas Trunkline

The Alberta Gas Trunk Line Co., incorporated in Alberta to build the gathering grid for the Trans-Canada pipeline, has awarded its first contract for the crossing of a gathering lateral under the Red Deer River near Cavendish. The lateral will bring production from the Bindloss, Provost and Sibbald fields to the main pipeline at the Field Gate. Length of the crossing is 2600 feet.

The Annacis Industrial Estate

In the past few years there has been a steadily growing demand for industrial lands to accommodate the expansion of secondary industry in British Columbia. The focal point of industrial development has been in the lower mainland area surrounding Greater Vancouver, which presents outstanding advantages with two major sea ports, one in Burrard Inlet and the other at New Westminster on the Fraser River.

Good transportation, moderate climatic conditions, and the many advantages for good living and recreation, make it a most attractive spot. Markets in Western Canada have been rapidly increasing over the past 10 years. Nearly 2,500,000 live in British Columbia and Alberta. Latest B.C. figure is 1,320,000. South of the border lies an American market with a population exceeding that of the whole of Canada.

Taking all these points into consideration, the Grosvenor Estates of London, England purchased Annacis Island in the harbour of New Westminster, and commenced development of this 1200-acre plot of land, and thus began Annacis Industrial Estate. The whole island is being developed for the accommodation of light and heavy industries, bulk breaking and packaging plants and warehousing.

The first of a series of four areas has already been completed. This area was filled with sand from adjacent river channels, presenting a good bearing for light and heavy construction. Excellent drainage facilities as well as sewerage systems have been installed along with an adequate water supply. Permanent, wide, main and secondary roadways are being progressively developed. Annacis maintains its own engineering and construction teams. Companies may have buildings designed by their own architects.

Spurs are provided to industries requiring rail service, while a strip of land flanking the channel has been set aside for industries requiring deep sea shipping facilities. A general cargo docking area is planned. Vancouver airport lies only 20 minutes from the Estate by car or bus. A heliport is also planned.

A most attractive feature is the landscaping of the areas bordering main roadways and buildings to give a parklike atmosphere. Power and cheap natural gas are available. Piped oxygen, display centres, shopping facilities, medical services, banks, clubs, fire protection and other services and amenities will be provided.

Architectural designing of all buildings will conform to a high standard of appearance. The Estate provides factory space and erects factories and warehouses to the specifications of the tenant, developed on a terrace basis under one roof which can be divided into units of 6000 square feet. Buildings are also erected to specification on separate sites according to the tenant's requirements.

Annacis is being developed on a leasehold basis. Upon signing the lease, the Estate guarantees delivery of a complete building or buildings and site. It is also possible for a tenant to lease the site and erect his own factory.

Since the official opening in July, 1955, there has been a steadily increasing tempo of development. 21 tenants have signed leases, 19 are already occupying premises. With more buildings being rushed to completion, and leases in various stages of negotiation, Annacis is thus well launched on the first 200-acre stage of development.

Within ten years the management expects half the island will be covered with factories, compared with about one sixth developed to date.

Though it was originally planned to encourage British industrialists to open Canadian branches at Annacis, of the twenty firms on the island today only two are British. Six are American, three are Canadian subsidiaries of U.S. firms and the other nine are Canadian.

N. P. D. Building

The contract for the construction of the building to house Canada's first power reactor has been awarded to The Foundation Company of Ontario Limited, it was announced recently by Canadian General Electric Company, Ontario Hydro, and Atomic Energy of Canada Limited.

Total amount of the contract for station building work is slightly in excess of $1,000,000. Work consists of site development, setting up of a construction camp, excavation, and carrying out of concrete and superstructure construction.

The Nuclear Power Demonstration station building will be located on the Ottawa River a few miles downstream from Ontario Hydro's Des Joachims generating station. The building will be 200 feet by 200 feet in size, with a steel frame and asbestos siding. The structure will be 40 feet above ground at its highest point and will have concrete works extending to 60 feet below ground level. It is scheduled for completion in the fall of 1957.

The N.P.D., with a capacity of 20,000 kw., is scheduled to come into operation in 1959. It is a joint undertaking of three organizations. Atomic Energy of Canada Limited is supplying basic research and nuclear engineering knowledge; Ontario Hydro is providing the site, is responsible for the engineering of the conventional features of the plant and will operate the station on completion; and Canadian General Electric is responsible for the engineering design and development of the reactor and acts as prime contractor for the whole project.

Canadian Oil and Gas Pipelines

Besides the two great pipeline projects, Westcoast Transmission and Trans Canada Pipelines, progress of which is being reported monthly in the *Journal*, great activity in laying pipe for both natural gas and crude oil pipelines has been occurring elsewhere during 1956, most of it in the three priairie provinces.

During 1956, including the expected 450 miles for Westcoast and 200 for Trans Canada, a total of some 1,350 miles of natural gas mains and laterals have been laid in the ground. Added thereto will be some 800 miles of distribution systems in various cities and towns from Vancouver of Toronto.

Although crude oil pipelines fell into a secondary position, some 775 miles of crude oil pipeline were also built during the year, opening up new markets in Saskatchewan and Alberta and readjusting the geographical allocation of fields to markets in both provinces.

Natural Gas Pipelines

Midwestern Industrial Gas Ltd. and North Canadian Oils Ltd. built a 10-inch composite gas line 170 miles long from the Alexander Indian Reserve field in Alberta to Wabamun and Hinton, in northern Alberta, to serve a large power plant and paper mill there.

South Alberta Pipelines Ltd. completed a 55-mile, 10-inch gas pipeline at a cost of $1.7 million from the Etzikom gas field in southern Alberta to serve the new Nitro-Chemicals Ltd. petro-chemical plant at Medicine Hat with 9 million cubic feet per year. The line will supply the city of Medicine Hat with 1 billion feet the first year and up to 3 billion feet the seventh year.

In the south west corner of the province British American Oil Company's 7-mile gas pipeline to the company's recycling plant neared completion.

Canadian Western Natural Gas and Northerwestern Utilities Ltd. made extensions to their existing systems of 109 miles and 68 miles respectively, tying in a number of large towns in Alberta not previously served with natural gas.

The Saskatchewan Power Commission laid 249 miles of main line and laterals, of which 120 miles of 12-inch gas pipeline from the Success field to serve the city of Moose Jaw, was the largest undertaking.

City and town distribution systems for natural gas at various points from Vancouver to Winnipeg and in Toronto's metropolitan area will add another four million feet or approximately 800 miles either completed or under way.

Crude Oil Pipelines

In Alberta, the Peace River Oil Pipeline Co. completed its system with 45 miles of 12-inch and 16-inch main line and 33 miles of 8- and 4-inch gathering lines. Cremona Pipelines Ltd. put into operation its 60-mile, 8-inch line with 10 miles of 6- and 4-inch feeders, to connect Calgary refineries with the Westward Ho, Sundre and Harmattan-Elkton oilfields.

Britmol Pipeline Co. Ltd. added 33 miles of 8-inch crude oil pipeline to the south end of its system to tie in the West Drumheller field with the line which now serves the Joffre and Fenn-Big Valley fields. Texaco Exploration Co. laid 22 miles of new 12-inch line to extend its present system from the Westerose area south to the Holmglen Rimbey field. Here it would connect with the new 44-mile line being built by Rangeland Pipeline Co.

Also in Alberta, Pembina Pipeline Ltd. was extending its large gathering system and raising its main line throughput to a level which was not originally expected to be attained before 1960. The construction schedule calls for 170 miles to bring total mileage up to 352 miles. This status should be achieved in 1957.

Further east, the Westspur Pipeline Co. laid 109 miles of 12-inch crude oil pipe, 10 miles of 8-inch pipe and 50 miles of gathering lines from fields in southwestern Saskatchewan to the interprovincial pumping station at Cromer, Manitoba.

Transprairie Pipelines received a permit to build 17 miles of 8-inch crude oil pipeline from the Halbrite field to Weyburn, Sask. It will link up with the Midale terminal.

The South Saskatchewan Pipeline Co. laid 59 miles of 12-inch and 7½ miles of 8-inch pipeline, including one river crossing, extending its existing line from Cantuar to Dollard, Sask., to take in four additional oil fields in the area.

Closely related to both these Saskatchewan projects is the expansion program of Interprovincial Pipeline Co., which looped its bottleneck section in the central part of its Manitoba division. The job consisted of 67 miles of 24-inch loop and 2 miles of 26-inch loop — the first leg in Manitoba of a continuous 30-mile loop of its Minnedosa line section operated by Lakehead Pipeline Co.

Interprovincial also added a seventh pumping unit at Cromer and further tank capacity at Cromer and Gretna. Throughput from Gretna was soon to be increased from 29,000 to 38,000 barrels per day in the 75-mile line of the Winnipeg Pipeline Co., an Imperial Oil subsidiary.

In Eastern Canada, products pipelines continued to expand their traffic volume faster than expected, and plans to loop one major products pipeline in Ontario were completed. Interprovincial announced firm plans to extend its line from Sarnia to a new destination at Port Credit, with construction to be done in 1957.

Research and Engineering

The new research and engineering facilities of Imperial Oil Limited at Sarnia, Ont., were opened in October.

At this time a symposium, attended by deans and professors of chemistry and engineering from across Canada as well as leaders of industry and government, was arranged to discuss research and engineering problems of mutual interest. Subjects of discussion included the role of industrial and institutional research, the use of scientific manpower, and the selection and training of technical personnel. At its conclusion Dr. E. W. R. Steacie, president of the National Research Council officially opened the new building.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE ELECTIONS AND TRANSFERS

What Can Be Done About It?

The supply of engineers and scientists for Canada's future is now and will be for several years quite inadequate. The picture is so clear and so alarming that it is hard to know why something more isn't being done about it.

More words have been spoken and printed about this situation than about almost anything else, with the possible exception of the international situation, and the latest sporting events. Many organizations have studied the situation and reported their findings. Many voices have proclaimed the urgency but after years of talk no one has done anything of consequence that will improve the situation quickly.

The full answer is not easy to find or to apply, but surely there can be some long distance thinking that will start a movement in the right direction.

In case the seriousness of the situation is not appreciated, the *Journal* presents herewith some of the latest information, which should convince anyone that the present troubles will be multiplied and aggravated beyond all reason, if we do not tackle the problem now. We have played with it long enough.

Let us look at the picture. There are three angles from which it must be regarded before it can be seen in all its seriousness. Firstly, what is the need? Secondly, how many are we graduating? And thirdly, how many are we getting by immigration?

First, the need. No one can say precisely how many engineering openings there are, but a partial answer can be developed, that is sufficiently disturbing to command attention. Taking the word of various engineering deans and staff members who have something to do with employment, it is safe to say that after eliminating duplications, this Spring each graduate had at least three jobs he could take. There were 1,600 graduates, so let's call the need at that time as 5,000.

Bear in mind this figure is for new graduates only. Add to it the need for experienced engineers and we have at least 1,000 more.

Secondly. — How many graduates will there be? In 1957 the figure will not be above 1,900. There will be a slow rise in numbers for several years and in 1965 it is indicated enrolment figures will double those of 1955.

Thirdly — How many come here from other parts of the world? Counting both engineers and scientists there were 1,900 in 1953. There were 500 who left Canada in the same year, so the net gain was 1,400. Graduates in engineering that year numbered 1,300. It will surprise many to know that for a short time Canada was gaining more by immigration than by graduation.

Now if immigration is added to graduation in 1953, we would have 2,700 new acquisitions that year. The demand at that time was about 6,000, so even under those favourable conditions we were short at least 50 per cent of the requirement.

A serious trend is now becoming apparent. Acquisition by immigration is falling off alarmingly. In 1953 it exceeded graduation but in 1955 it amounted to only 60 per cent of the number of graduates, or about 800. The economic conditions in other countries are improving to the point that their engineers and scientists are content to stay home. Barring some serious upheaval, immigration never again will be so important a factor in the Canadian picture.

Now let us look ahead to 1965 which is the target date for so many plans and conjectures. According to Dr. Sheffield of the Dominion Bureau of Statistics, university enrolment then will be double that of 1955. If such is the case, the maximum number of engineering graduates in 1965, will not be more than double the 1955 number, or 2,600.

If immigration figures follow their trend, the number available from this source in 1965 will not exceed 500, and in all probability will be much less.

Putting these two figures together, there will be in 1965 about 3,100 new acquisitions.

Now what will be the demand then? A recent survey of over 700 employers of Canadian engineers shows that they expect to increase their needs by 10 per cent per year for the next three years. If this carries on until 1965 the need will be at least 12,000 per year at that time.

The arithmetic is simple; the answer impressive. With a need of 12,000 engineers and a graduation class of 2,600, the situation becomes startlingly clear. Some will argue that industry will not require 10 per cent more graduates each year, but the figure is definite for at least three years. It is not unreasonable to assume that in this growing country with its great potential, industry, government and universities will require that many.

To meet the argument of those who think these figures are unrealistic, let us examine the situation as if industry's requirements remain just as they are today, that is to say, that the need would be about 6,000, as it is now. The graduating class, if it doubles the 1955 figure, would be 2,600. There is still a shortage of almost 50 per cent and even that is a matter so serious that more attention should be given to it—atten-

Cover Picture

A modern Canadian boiler installation for a large industrial plant is shown on our cover.

There are four boilers, each having a designed steam capacity of 100,000 lb. per hour at 150 p.s.i.

Photo courtesy Babcock-Wilcox and Goldie McCullough Limited.

tion that will produce some changes quickly.

The Answers

Who knows the answers? Apparently everybody and nobody. This situation has been foreseen by many people over a period of years, long enough to have brought about some worthwhile improvement, if those who have the power had seen fit to do anything about it.

At long last there is an increase in the tempo of the thinking, but alas, the possibility of bringing about improvements in the near future is not encouraging. University officials are almost powerless to do anything by themselves, but they are now planning in terms of the immediate needs. However, they need money — money for buildings, for increased salaries, for increased staff, for additional and improved equipment. There is some promise now that government and industry will help, but the needs appear to be away beyond any sums that are being mentioned as available shortly. The planning needs to be expanded greatly or the situation will not be met.

Technicians

One of the quickest and best methods of overcoming the shortage is to train more technicians. Many hours of work now done by professional workers could be done equally well by properly trained technicians, but the supply of technicians is just as inadequate as is the supply of engineers. Here too there are but few signs that anything is being done about it.

The Province of Ontario has made a fine start with its Ryerson Institute of Technology at Toronto, but the number of graduates is hopelessly small in terms of the needs. Fortunately the province is expanding its teaching facilities in this field and there is excellent promise of worthwhile improvements shortly.

Effects

Through the survey of employers referred to earlier it was discovered that the shortage was having adverse effects on production, research and expansion. Out of over 700 firms surveyed, 360 reported that their operations had suffered from the shortage. They mentioned such effects as delay in new projects, inability to tender on new projects, reduced expansion, research retarded, no opportunity to train young executives, expanded use of improperly qualified personnel, overwork of professional employees with corresponding reduction in efficiency and so on.

So —

As admitted earlier, there appears to be no means of meeting this situation immediately, but surely some better planning can be done and more active support can be offered than has been apparent so far. The situation is serious and merits treatment as an emergency.

Hungarian Refugee Engineers

Indications are that several thousand refugees from the Hungarian terror will come to Canada. They will represent a cross-section of the Hungarian population and there will be engineers among them. Council has directed that the Institute give all possible help to refugee engineers in their efforts to find work and to become members of the Canadian community.

Immigration Offices and National Employment Service are the government agencies concerned with the refugees, assisted by various welfare organizations. So far, efforts to find out how the Institute could assist most effectively have not been too successful. There is still some organizing to be done.

The Institute has already made available the facilities of the Employment Service and of the *Journal*. When arrival and dispersal points are known in advance, branches at these points are advised and asked to help. However, advance information is not always obtained and all branches are asked to be on the lookout for arrivals in their communities.

The branches can help in two ways: First by asking to be advised of the names and qualifications of engineers among the refugees to help them find employment, then by inviting them to branch meetings where they can meet prospective employers and make friends with their Canadian colleagues.

Individual members may help by rounding up some of the jobs they intend to get done but postpone time after time because no one can be spared to do them. Perhaps a refugee can do one of these jobs or relieve a Canadian engineer of some of the routine details of his work. Such assignments, even for temporary periods, will help the refugees to become familiar with our language, our methods and our customs.

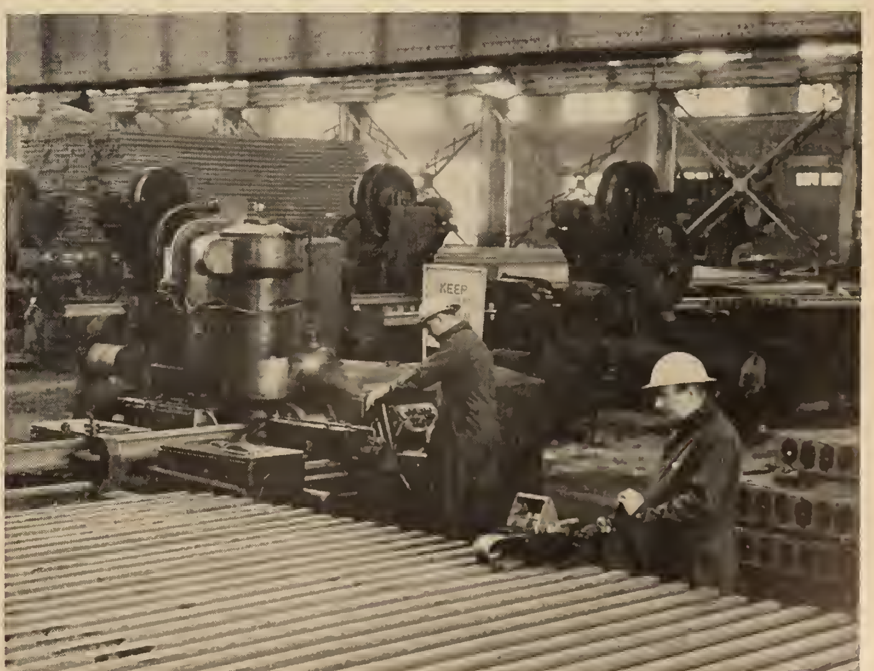
Most Europeans with college educations have studied English and French. Nevertheless, there will be serious language difficulties in many cases. For those who speak neither language it may be necessary to find work at sub-engineering level, at least for a while. Temporary jobs as draftsmen, technicians or machine operators will be more suitable and useful than the jobs these trained refugees might otherwise have to take.

Headquarters will help the branches as much as possible, but most of the work will have to be done where the refugees are. The branches are asked to keep headquarters informed of the assistance given these refugees in order that progress reports may be published in the *Journal*.

At present, enthusiasm is very high. Welfare agencies are receiving many offers of help, to the point where they do not quite know what to do with them. But enthusiasm tapers off. For this reason, the efforts of the Institute will need to be sustained to assure the late comers an even break.

End hardening rails at the plant of Dominion Steel and Coal Corporation, Sydney, N.S. This photograph received an award of merit in the E.I.C. photographic exhibit, 1956.

Photo by Abbass



A Proposal for a Survey of the Engineering Profession

From the report of the ECPD-EJC Joint Task Committee on Engineering Profession Survey

Editor's Note :

One of the most important things the profession in North America will have to face in the immediate future is outlined in the following article. In the minds of many people who have studied the situation it is essential that this survey go forward.

If it is undertaken the Engineering Institute will become deeply concerned with it. As the only Canadian member of the Engineers' Council for Professional Development it will fall to the Institute to carry out or supervise all the phases that will have to do with Canada.

This is a serious matter. Never before has there been a proposal so far-reaching, so comprehensive and so significant to the profession of engineering. It will pay the readers of *The Engineering Journal* to study it.

The ever accelerating pace at which expanding scientific knowledge and discovery is rendered useful by the engineer has stimulated a world-wide revolution. By force of momentous advances that are still in progress, the engineering profession has assumed broad responsibilities, among which its traditional concern with individual professional competence is only one. The engineering profession today is the most complex of all. The present shortage in engineering manpower, serious enough by itself, has served further to underscore many other major problems confronting the profession. It has raised more questions than have been answered.

Critical problems have arisen in every facet of the profession: education, utilization of manpower, organization, and social and economic factors, all of which intimately concern the national welfare. It therefore seems appropriate, necessary, and, in fact, urgent that the engineering profession at this time make the first searching and comprehensive self-study in its history.

If it were a matter of numbers alone, the engineering profession and the nation would face a somewhat less formidable problem. But the pattern of the future is already being drawn in the affairs of today. Society and technology have not only utilized the professional competence of the engineer, they look to him to supply managerial and executive ability as well. To cite just one example, answers to the problem of natural resources will almost certainly hinge on the decisions and accomplishments of engineers. The engineer often works without the spur of public concern that, for example, accompanies medical research. More than ever today the engineer must possess the technical and intellectual discernment to anticipate problems and solve them almost before others think of them. Inevitably, engineers make policy in a host of industries and vast government agencies which a decade or two ago looked to the corporation lawyer, the financier, or a political figure for the lead. Just as inevitably, in a period when the battle between freedom and totalitarianism is waged with bread and know-how, national policy must be drafted with the aid of engineers.

The Time Is Now

The decision toward an undertaking so immense as a Survey of the nation's largest profession is not easy and ought not to be made with undue haste. Five years of informal and formal deliberation and introspection lie behind this call for the Survey. It is issued not only because the time is propitious, but also in the belief that delay will do injury to the living and to generations to come. Action born of crisis can be precipitious; but if that action springs from competence, integrity, and authority, it is likely to lead to vast strides forward.

Enlightened Self-Interest As Well

Among the great professions, engineering may take justifiable pride in its reputation. It has been uniquely free of mistrust, scandal, ridicule, and charges of incompetence or inertia. Having earned universal respect, the profession must not complacently assume that this is a permanent grant. If in the future shortcomings should bring deserved criticism upon the profession (to say nothing of abuse and threats to professional freedoms) it will have only itself to blame. Assuming this concern to be, frankly, one motivated by self-interest, it is nevertheless interwoven with the primary obligation of the profession to society.

To measure up to the tasks required of it, the profession must be assured that it is properly training, utilizing, rewarding, and attracting men of the highest competence and potentialities. No responsible person can honestly say that all is well in these areas today. Only a top-to-bottom Survey can determine the nature of the mission, the extent to which it is being fulfilled, and the steps necessary to maximize our efforts in the most effective manner.

The Personality of the Profession

The profession is composed of individuals. The danger that this will be forgotten grows as the proportion of engineers to other groups increases inexorably. Indeed, neglect of the individual has always been a tendency in a profession distinguished from many others by the fact that most of its members are employees rather than self-employed. Despite emphasis on quantity, society and technology now clearly demand of engineers a high order of intellectual capability, individuality, imagination, and ability to assume responsibility. The Survey must therefore probe not only the day-to-day tasks of the engineer but also his attitudes, hopes, ambitions, disappointments, and fears.

The Spirit of the Survey

Other professions have surveyed themselves thoroughly — under less pressing circumstances than face the engineering profession today. The two most recent studies yielded significant pictures of the American architect and the American lawyer. These are cited merely as a matter of record; only to a minor extent could they serve as models for the Survey of engineering. Engineering's needs seem to call for a type of investigation more akin to the Hoover Commission's study on governmental operations.

The Scope and Uses of the Survey

In each of the great areas the Survey will:

Seek comprehensive knowledge of the facts of the existing situation.

Formulate answers to many penetrating questions arising from the facts.

Make recommendations for future action.

Provide ways and means of putting the recommendations into actual practice.

If it truly penetrates every aspect and level of engineering, the Survey's constructive conclusions may well be expected to provide guides for the profession for the next quarter-century. Not that engineering should straightjacket itself, for it is by nature dynamic and changing. But the great problems this Survey will attack are of a kind that not only will remain with us for the next generation but may be expected to come into sharper focus and carry even greater significance than now.

Following are the areas with which the survey must be concerned, together with an indication, not intended to be complete, of questions in each area that cry for investigation and solution.

1. Professional Services and Responsibilities

Today the essential of individual technical competence is but a starting point of the engineer's role in society. Past concepts, performance, and evolution of the profession should be analyzed to obtain an up-to-date perspective on present and future problems. Therefore,

What are the strictly professional responsibilities of the engineer?

To what extent do engineers influence the application of their professional efforts?

What are the gaps in intellectual leadership that could be, should be, filled by engineers?

To what extent should professional education and organization be altered to equip the engineer for new, untraditional services and responsibilities?

2. The Supply of Brain Power

To meet the spiralling demands for both capital and consumer goods, the productivity of human effort must be rendered increasingly more effective. At the same time the intricacies and refinements of modern production take a growing percentage of engineering man-hours from inception of an idea to the fabrication and assembly. For example, a 1940 fighter plane took 17,000 man-hours of engineering, a 1955 took 1,410,000, and a 1960 promises to take 2,000,000. Engineering must share with the other professions and intellectual occupations a relatively small reservoir of talented youths. Of the mere 17% of high school graduates intellectually suited to engineering education, engineering colleges are drawing one-fourth of the male portion. A single profession enlisting so great a proportion of this precious human resource assumes grave obligations and responsibilities. Therefore,

From a completely objective and unemotional study, what are the specific shortages, present and projected? Careful statistical studies should deal not alone with the over-all situation but with industries, branches of engineering, and professional levels (consulting, industrial, teaching, and research).

What are the demands of the other professions on the national supply of brain-power? Will these brains have to be rationed? If so, what should be the order of priority?

In general terms, and in case studies, how are engineers utilized?

Depending on the specific shortages disclosed, how can they be alleviated: by regimentation, incentives, better utilization, changes in education, variation of standards, or by other means?

If the growing concentration of numbers in this one profession tends to depress the morale and initiative of its members, how may this be remedied?

3. The Individual Engineer

Because he often works in teams and is usually an employee, the individual engineer is too often anonymous. The tributes he has earned are frequently paid to his profession in the mass. Therefore,

What is an engineer? Who is he, and what are his origins and his social, cultural, and economic background? For the purposes of outlining an operable framework for the Survey, the Survey Committee must first establish a definition of who shall be termed "an engineer" and therefore be included in the study. To do this, the areas of activity of engineers and those of scientists must be delineated.

Why did he choose engineering? What was the nature of his intellectual preparation, and how did it affect his subsequent career?

What made him choose his particular branch or level of engineering?

How much does he earn, and how much can be expected to earn throughout his career? What are his living standards?

What are his personality traits, and how do they affect his professional performance?

Does the fact that so many engineers are employees adversely affect their professional outlook? Is there a different outlook among those who are self-employed or in policy-making positions?

What are his initimate feelings about his profession, about the organizational pattern in which he functions? How does this pattern encourage or discourage his individual talents, initiative, and imagination?

What do his employers and nonprofessional colleagues, family and friends think of him? How does he rate in his community or in the business world compared with members of other professions?

All other factors being equal, is he more valuable for having remained in one job for many years or having switched often?

What are the effects of pension systems, and other devices to make employment more attractive and reduce turnover, on the freedom and development of the individual engineer?

Does he attempt to advance himself after he leaves college, and by what means?

Does he have nonprofessional interests, in individual pursuits and in his community?

4. Subprofessional Engineering Services

Like the brain in the central nervous system, the engineer triggers activity by men and women in a greater number of allied occupations and skills: at the same time, he receives information and services from them in order to perform the tasks requiring his particular professional ability and judgment. This is true of other professions, though their allied subprofessional services seem to be more thoroughly and rationally organized. It is ludicrous to imagine a cardiologist or other medical specialist performing the functions of a nurse, an X-ray technician, or a bacteriological aide. Yet many professional engineers are found in comparable situations. Therefore, What are the specific types of subprofessional services allied to professional engineering? Should more women as well as men be enlisted into them?

To what extent are professional engineers engaged in them?

What are the educational requirements for subprofessional services? What are the existing and needed educational facilities for them?

What kind of people should be attracted to these services?

What recognition can be given them? What opportunities should they have for transfer to professional status?

What mechanical, as well as human, aids are given to the engineer?

To what extent can expanded and better apportioned subprofessional activities alleviate shortages in the profession?

5. Engineering Education

The ink is scarcely dry on the last extensive survey of engineering education. More spadework having been done in this area than in any other aspect of the engineering profession, the job of the Survey will be to crystallize the basic problems of engineering education as they relate to other areas of the Survey and to make comprehensive, detailed, and realistic recommendations for solutions. Among the following questions, the Survey will have considerable information on some, may choose to examine others in still greater detail, and may want to put others to thorough examination by eminent laymen as well as by engineers:

What do we mean by engineering education?

What is the contribution of the educational system to the development of the professional engineer from secondary school through postgraduate study?

Is engineering education too formal, stereotyped, and rigid? Does it foster or inhibit originality and creativity?

What is the actual cost of educating an engineer? How is it paid?

How are engineering schools financed, staffed, and equipped?

What is the composition, ability, and morale of engineering faculties? How may schools retain outstanding faculties in the face of competition from other areas?

What are the causes and implications of the heavy mortality in engineering students?

To what extent should social and humanistic studies be effectively integrated into engineering education?

Should some engineering studies be introduced into educational programs for other professions?

How far should formal graduate work go? Who should pursue it?

To what extent is the advancement and utilization of older engineers (those out of college five years or more) impeded by lack of opportunity or incentive for keeping abreast of new advances in engineering and science?

What procedures can encourage continuing education stimulating to the engineer, not restrictive of his family life and finances, and advantageous to his employer?

6. Registration and Unionization

Compared to his invaluable contributions and widespread prestige, the legal status of the engineer and his personal relationship with his profession lag far behind and are relatively ambiguous. The fact that 48 states have registration laws fails to meet the hard truth that while a doctor is a doctor, a lawyer a lawyer, a minister a minister, too often an engineer is all things to all men. Of all the professions, engineering has the most members of labor unions. Therefore,

Should mandatory licensing be expanded? Should engineers be licensed broadly or in particular fields?

Why do engineers register or not register?

Has registration improved engineering ethics and the level of engineering services to the public?

What problems arise from the practice of engineering through the corporate form of business?

What is the nature and extent of unionization?

Why do engineers join unions? How does union membership affect their professional competence and subsequent careers?

What is the organized profession's attitude toward unionization?

Are there advantages and disadvantages in unionization that affect the profession's role in society?

7. Organization of the Profession

Many societies, organized along branch lines, flourish within the engineering profession. The societies are organized in two federations. The profession has no true counterpart to the American Medical Association and the American Bar Association. On the other hand, those national organizations are comparatively new institutions in the history of their professions and their function and value, if related to the Survey of engineering, should be studied rationally and objectively. Therefore,

For meaningful organization purposes, what are the major branches of engineering?

Is the engineering profession cohesive?

What is professional unity and how does it affect maximum professional service?

Are changes in the organization of the engineering profession desirable?

What is the political, social, and economic status of the profession?

What are its relationships to scientific organizations, industrial associations, labor and political organizations, the military, and other professional organizations?

The Role of the Societies

A Survey of the engineering profession will require at least two years. It will cost on the order of $1 million.

The details of organization and procedure of the Survey clearly cannot be spelled out in advance. For one thing, they require long and careful planning. For another, they demand a plan for consultation with all of the constituent societies, a step requiring that the societies first endorse this proposal in general terms.

Generally, however, this joint committee suggests the establishment of a Committee on the Survey of the Engineering Profession under the joint auspices of ECPD and EJC.

Following the lead of recent self-studies by other professions it seems logical to organize the Survey so that various groups would investigate specific items on which they are best qualified. Such groups need not be composed solely of engineers since engineering embraces a spectrum of activities much broader than the technical competence of the individual engineer. The calibre and distinction of the directing committee should be of a level to arouse enthusiasm and support in areas outside as well as within the profession.

The Committee Would

△ Outline a form of organization to conduct the Survey, using the present proposal and supplementary suggestions from the constituent societies as a basis. It will doubtless be desirable to explore the extent to which one or another problem is peculiar to a given segment of the profession, so that special groups in one or more constituent societies may become special agents of the committee.

△ Appoint a director and small staff to assist in detailing the program and later administering it under the committee's auspices.

△ Make progress reports to the Executive Committee of ECPD and the Board of Directors of EJC, so that constituent societies may be continuously informed through their representatives.

Manifestly, the Survey cannot and should not be undertaken without the enthusiastic endorsement and support of the national engineering societies. The unity of the profession on the desirability of the Survey must be unmistakable before others are asked to lend their support.

The Reason Within Us

The future pattern of engineering will, to an extent undreamed of by many, influence day-to-day schedules in factories and mines, the size and shape of the national product, the face of the city and countryside, conditions in homes here and abroad, and the respect with which American words are heard at conference tables the world over. This is verified by historical and technological reality and by a sense of great works — wonders, if you will — that lie somewhere in the traditionally unemotional engineer. It is the preservation and extension of that sense that we cite as our final reason for the Survey of the engineering profession.

Manpower Conference

The Advisory Committee on Professional Manpower had another meeting in Ottawa on Monday, October 29. This is an Advisory Committee of the Department of Labour and therefore the meeting was opened with a welcome and expression of thanks from the Deputy Minister, Mr. Arthur Brown. The Minister, the Honourable Milton Gregg, V.C., joined the group in the afternoon and stayed throughout that session.

The agenda provided for nine topics of discussion and each topic was introduced by an official of the Department of Labour or some other government department and was followed by a very general discussion. Herewith are the topics and the persons who presented the papers and led in the discussions.

Introductory remarks, Mr. A. H. Brown, Deputy Minister of Labour.
The long-term outlook of professional personnel, Dr. W. R. Dymond, Department of Labour.
1956 Survey of Requirements for Professional Personnel, Mr. A. M. Sargent, Department of Labour.
Technical Personnel Register and other developments since the last meeting, Dr. P. H. Casselman, Department of Labour.
Professional health personnel, Miss B. J. Stewart, Department of National Health and Welfare.
Economic status of engineers and scientists, Mr. F. L. McKim, National Research Council.
Comments on program of university expansion, Dr. F. Stiling, National Conference of Canadian Universities.
Comments on Industrial Foundation for the Advancement of Education, Mr. S. H. Deeks, Executive Director, Foundation.
Comments on shortage of science teachers in high schools, Dr. Garnet Page, Chemical Institute of Canada.
Other business.

There were about fifty persons at the meeting, which by the way took place in the Liberal Caucus Room in the House of Commons building. It certainly must have been inspirational, at least to some of the persons in the room, to be surrounded with busts and portraits of such distinguished Liberals as Sir Wilfrid Laurier, Mackenie King and Louis St. Laurent.

For this meeting the membership of the committee was extended substantially over previous meetings. For instance, there were two delegates from the Canadian Chamber of Commerce, two from the Canadian Manufacturers Association and one from the newly formed Industrial Foundation for Education. Other organizations and departments which were represented are as follows:—

Representatives to the Advisory Committee on Professional Manpower Meeting—October 29, 1956

Mr. L. W. J. Hurd, Agricultural Institute of Canada
Mr. C. J. G. Carroll, Royal Architectural Institute of Canada
Dr. Garnet Page, Chemical Institute of Canada
Mr. J. M. Muir, The Dominion Council of Professional Engineers
Dr. L. Austin Wright, The Engineering Institute of Canada
Mr. J. D. Coats, Canadian Institute of Forestry
Mr. C. Gerow, Canadian Institute of Mining and Metallurgy
Dr. A. E. Douglas, Canadian Association of Physicists
Dean F. Stiling, National Conference of Canadian Universities
Dr. C. T. Bissell, National Conference of Canadian Universities
The Very Rev. R. Normandin, National Conference of Canadian Universities
Mr. W. H. Evans, Canadian Manufacturers Association
Dr. J. R. Whitehead, Canadian Manufacturers Association
Mr. W. J. McNally, Canadian Chamber of Commerce
Mr. E. R. Complin, Canadian Chamber of Commerce
Mr. S. H. Deeks, Industrial Foundation on Education
Mr. F. G. Patten, Canadian Educational Association
Mr. T. W. Morison, Atomic Energy of Canada Limited
Mr. M. Lamontagne, Economic Adviser to the Prime Minister
Mr. G. D. Mallory, Technical Adviser, Department of Trade and Commerce
Dr. E. F. Sheffield, Director, Educational Division, Dominion Bureau of Statistics
Dr. F. T. Rosser, Director, Division of Administration, National Research Council
Dr. J. B. Marshall, Chief, Awards Branch, National Research Council
Mr. F. L. McKim, Chief, Personnel Branch, National Research Council
Dr. H. W. Jamieson, Director of Personnel, Defence Research Board
Miss B. J. Stewart, Research and Statistics Division, Department of National Health and Welfare
Col. G. M. Morrison, Supervisor, Executive and Professional Division, National Employment Service
Mr. A. H. Brown, Deputy Minister, Department of Labour
Dr. G. V. Haythorne, Assistant Deputy Minister, Department of Labour
Mr. A. W. Crawford, Director, Canadian Vocational Training, Department of Labour
Miss M. V. Royce, Director Women's Bureau, Department of Labour
Mr. W. E. Duffett, Director, Economics and Research Branch, Department of Labour
Dr. W. R. Dymond, Chief, Manpower Division, Department of Labour
Dr. P. H. Casselman, Chief, Specialized Manpower Resources Section, Department of Labour
Mr. J. P. Francis, Department of Labour
Mr. J. A. Wedge, Department of Labour
Mr. P. B. Wolfe, Department of Labour
Mr. A. M. Sargent, Department of Labour
Mr. K. N. Williams, Department of Labour
Mrs. E. M. Glavin, Department of Labour
Miss J. Marlow, Department of Labour

One subject which was of considerable interest was related to the Canadian undergraduates and graduates who go to the United States for further study. The problem here is how to get them back to Canada after they have completed their studies. Efforts are now being made to prepare lists of such persons and it is hoped that the Department of Labour may keep in touch with them through their national register and offer them encouragement to return to their native land.

It was agreed by the three Institutes that they would supply the Department with the names of their young members who made the Institutes aware of their transfer to the United States. In many instances these young men send in a change of address, in other instances they ask for the privilege of paying students' fees only while they are at college and in some cases they offer their resignation. It was felt that if this information were passed to Ottawa, close contact could be maintained with them, which may be influential in preventing their loss to the United States.

Survey of 1956 Needs

A. M. Sargent presented a report in the 1956 survey of needs of industry for professional workers. There were some startling figures and graphs but the group were informed that this whole report was still confidential and permission was not given to publish any or all of it at the moment. Suffice it to say that the demands for the future are substantial and there is every indication that there is nothing that anybody can do in this country that will develop a supply of engineers sufficient to meet the needs.

The enrolment in engineering this year is greatly increased over last year, but it will be between four and five years before this effect is felt and even then it is expected that the demands will have increased to such an extent that the additional supply will still fall short of the requirements.

The work of the Advisory Committee is extremely interesting. To some extent this group is similar to the Advisory Board established during the war as part of the Wartime Bureau of Technical Personnel. The register which is now maintained also is an outcome of that same effort. Members will recall that registration was compulsory during the war and that the Wartime Bureau of Technical Personnel was manned almost entirely by engineers, the director being E. M. Little, M.E.I.C., and the assistant director being L. Austin Wright, the general secretary of the Institute. The records set up at that time are the basis of the present registration.

Elections and Transfers

At the meeting of council held at Montreal, December 8, 1956, a number of applications were presented for consideration and on the recommendation of the Admissions Committee, the following elections and transfers were effected.

MEMBERS

R. Baldur, Montreal; J. J. E. Barcelo, Montreal; J. R. Crerar, Leamington; H. A. Delcellier, Ottawa; J. A. Desbaillets, Montreal; G. Finnie, Montreal; G. N. Fisher, Montreal; R. G. Griffith, Montreal; E. R. Gustafson, Fort William; R. E. Hughes, Montreal; E. Kraulis, Toronto; C. Langlois, Sherbrooke.

D. C. Musgrave, Ottawa; R. D. Mutch, Montreal; L. K. Narod, Vancouver; J. Norman, Montreal; C. G. Poulton, Three Rivers; A. Poumbouras, Sherbrooke; J. J. Russo, Montreal; D. M. C. Saunders, Whitehorse; G. N. Sheetikoff, Hamilton; J. Soare, Montreal; C. E. Stockman, Toronto; H. B. Tryhorn, Toronto.

FOR ADMISSION AS JUNIOR

R. H. Baylis, Montreal; P. Epp, Calgary; J. R. Griffin, Whitehorse; G. Heroux, Brownsburg; J. S. Howard, Montreal; D. M. Johnson, Hamilton; T. E. Lawson, Montreal; H. P. MacMaster, Arnprior; E. W. Thorne, St. Catharines; A. A. Tsapras, Montreal.

FOR TRANSFER FROM JUNIOR TO MEMBER

C. R. Baker, Washington; R. Burns, Montreal; M. J. Coady, Whitehorse; A. G. Hyde, Montreal; A. F. Joplin, Revelstoke; W. G. Mayberry, Galt; H. J. T. Patterson, Beaconsfield; D. W. Stairs, Kenogami; S. Thomson, Whitehorse; L. Trudel, Charlesbourg; D. Zavitzianos, Toronto.

FOR TRANSFER FROM STUDENT TO JUNIOR

P. T. Beauchemin, Montreal; D. C. J. H. Meredith, Scotland.

THE FOLLOWING STUDENTS WERE ADMITTED:

McGill University

J. A. R. Abbott, P. N. S. Annand, J. G. Anthopouloj, D. G. Barclay, P. Y. Beauparlant, N. M. Benoit, C. H. Bergstrom, O. Bernaus, A. G. Bible, G. Y. Bloomstone, S. R. Borenstein, W. H. Borlase, J. J. A. Boutin, K. R. Bradley, R. C. Brereton, I. R. Brunet, L. D. Burpee, D. H. Bush, G. C. Campbell, D. T. W. Chin, H. W. Clarke, H. A. Condy, C. S. Cook, J. Corej, R. Cross, B. A. Culham, E. A. Dainius, R. F. Darlington, E. J. Derome, J. R. Derome, G. M. Desjardins, E. Deskin, M. O. Diorio, E. Di Salvo, L. A. Donolo, D. A. Dorrance, G. Drupals, J. T. Dunn, A. Economides, W. H. Ellis, J. G. Feltrin, R. Foisy, J. Fong, W. Friedlander, D. B. Galuga, T. Gertin, A. Giannetti, R. F. Gosine, H. G. Griffith, D. E. Guitton, A. Haddad, G. S. Hamilton, N. Handiak, O. Hawaleshka, K. A. Henderson, D. I. Hughes.

C. F. Judson, H. W. Katz, D. J. Keenan, E. Keller, E. B. Kenwood, E. A. Kersulis, E. Kolankowsky, D. P. Komery, E. Konigsberg, R. Korol, K. Y. Kwong, Y. Kyssa, J. P. Laberge, R. Lajzerowicz, A. I. E. Lapin, R. A. Lapinas, A. E. Lapointe, M. A. LeBlanc, R. Lee, C. G. Leger, D. M. Lewis, A. L. Lippay, A. I. MacDougall, J. D. MacIntosh, T. Matsushita, J. Mazutis, P. Mermelstein, J. A. Michaud, G. E. Milburn, N. C. Morantz, L. P. Morey, M. Morin, S. E. Muir, W. E. Muir, F. J. Muszynski, J. G. Nault, R. C. Neapole, I. M. Nitkin, R. A. C. Noel, E. Norak, B. L. Novak.

S. P. Olsen, G. L. G. Oulton, G. Pajuk, V. Paulius, F. S. Philpott, A. B. Pusarauskas, F. J. Raimondo, J. P. Richard, C. S. Robertson, G. W. Ross, H. S. Rothman, F. Rousseau, M. Rozen, A. F. A. Ryan, J. P. Safford, V. Schecter, M. Schneerer, H. H. Schwartz, J. A. Sebastyan, B. M. Segal, D. J. Shlien, R. A. Simons, O. M. Skorzewski, R. P. Smithers, K. Soosaar, B. Sowinski, J. W. Storr, L. Strucchelli, C. K. Tanaka, R. Tanaka, J. N. Tilley, P. Tondi, B. Toporowski P. Tzimas, E. Vernigora, J. J. Wallace, D. G. Wallwork, M. Wein, R. A. Westoby, D. A. Wheeler, C. F. White, M. A. Wolanyk, Jr., H. Wong, D. T. Yamadka, R. E. Young.

Nova Scotia Technical College

H. K. Beatty, G. H. Brennan, K. D. Coleman, H. T. Doane, G. K. Fleming, B. S. Fulmore, R. L. Fulton, R. S. Giffin, M. A. Ibrahim, T. L. Jeary, J. J. A. Lefebvre, R. L. Neil, F. L. Rhyns, D. A. Seamone, C. L. Sherman, W. G. S. Smith, S. R. Stephenson.

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University of British Columbia

W. M. Calderwood, J. D. N. Cheeke, G. L. Clements, W. J. P. Crawford, G. R. Douglas, R. E. Elcox, E. A. Lund, N. W. Fletcher, M. Sydor, K. G. VanSacker, J. P. West, G. T. Wong.

University of New Brunswick

J. R. Ainsworth, A. S. Blanchard, R. M. Chiasson, B. R. H. Kishbaugh, J. M. Lowe, G. C. MacTavish, E. Motluk, A. N. Olyarchuk, W. G. Paterson, L. O. Pertus, R. G. Scott.

University of Alberta

I. H. Anderson, P. N. Balko, J. A. Brown, C. N. Ellert, G. C. Fuerst, O. J. Hahn, P. Kupin, J. P. O'Dwyer, D. J. Pawluk, B. H. Schultz.

McMaster University

H. Cipywnyk, A. E. Kozak.

Laval University

J. C. M. Lagace, J. D. Provencher, J. R. LaHaye.

Mount Allison University

E. H. Gilroy, W. T. Hopkins.

Royal Military College

J. M. Lebel.

Queen's University

R. Priolo.

University of Illinois

G. Eng.

Graduates

Geo. T. Harrap, B.Sc. (Chem.), Toronto, 1956; A. Opstad, B.Sc. (Elec.), Alberta, 1956; V. M. Cossette, B.Eng. (Civil), McGill 1956; B. W. Little, B.Eng. (Mech.), McGill 1956.

Ecole Polytechnique

B. Barbeau, G. Baril, M. Baril, R. P. Y. Barrette, J. G. Beauchamp, J. P. Beauvais, F. A. Belanger, G. G. Belanger, L. Belanger, L. Belanger, J. G. R. Belanger, A. Benoit, J. P. Berard, G. Bergeron, J. Blanchet, H. Blanchette, C. Boivin, B. Bouchard, M. Bouchard, B. Boucher, J. Boudreau, J. Boulanger, Y. Bourgoin, G. Boyer, J. C. M. Brassard, M. Brault, C. Brochu, J. Brunelle, R. Brunet, G. Bussiere, C. Bussieres, L. Caron, A. L. Chabot, B. Chapdelaine, C. L. Clossey, J. C. J. Cordeau, R. Cormier, C. Coudry, J. G. G. Courtemanche, J. R. Cusson, R. Cyr, M. Dagenais, M. d'Anjou, M. D'Arcy, P. de Broin, A. Desbiens, Y. Despatis, J. J. Dionne, J. Donato, A. Dugre, M. Durand, C. G. Duval,

R. Felx, R. Filiautrault, H. P. Filion, A. R. Forcione, A. Forest, P. Fortier, R. Frechette, P. Gadbois, A. Gagne, J. H. A. Gagne, J. Gervais, G. M. Girard, M. Giroux, J. P. Godbout, R. S. Goyette, M. Gratton, R. Grenier, N. W. Guerette, J. Hebert, D. Hogue, F. R. Laberge, Y. LaBrosse, C. Lachance, G. Lacoste, J. A. C. Lapalme, R. V. L'Archeveque, G. Laroque, G. La Tour, G. Lavigne, D. Lecomte, G. P. Lemieux, M. P. Lemoine, A. Loiselle, G. Lussier, J. M. Maccabee, S. Marcato, G. G. Marineau, G. Marquet, A. Marsan,

(Continued on page 55)

THIRTY-FIVE YEARS AGO

Comment on the Journal of January, 1922

Thirty - five years is half man's Scriptural life span; much can happen in it. This is brought to mind by the leading paper in the *Journal* for January, 1922, "General Oil Refining Practice," by C. D. Dean, M.E.I.C. The methods described in this paper would seem pretty crude to any petroleum chemist of today, but presumably they were quite up to date, since they were those of Canada's largest oil company.

Not being particularly interested in the oil industry, even as a speculator in a modest way in the hope of becoming rich overnight, the current ambition of a good many Canadians, this writer is certainly not qualified to discuss in detail the advances in oil technology since 1922. But it will occur to anybody that we are squeezing a great deal more out of crude oil and gas than we used to. Polyethylene plastics, liquid gases and by-product sulphur come to mind as comparatively new products in this field.

Speaking of natural gas, Dr. J. A. L. Henderson advised the Moncton Branch against using it for space heating "on account of waste". How many billions of cubic feet of natural gas do you suppose were used for just this purpose in 1956? The figures are not at hand, but must be astronomical.

W. P. Dobson, M.E.I.C., had a paper in this *Journal* dealing with electrical standardizing and inspection as carried out by the Hydro-Electric Power Commission of Ontario. And P. E . Biggar, S.E.I.C., wrote on "The Aeroplane Engine", an excellent paper, as true within its limits today as it was when written. Of course, there is no reference to jet or turbojet engines. The lightest of Biggar's engines was the 450-hp. Bristol Jupiter, which weighed 1.74 lb/hp.

Man's memory is short. A note in this *Journal* reminds the writer that he addressed the Montreal Section of the Society of Chemical Industry in late 1921 on a topic in which he was then interested. If it were not for the black and white evidence of this note, he would say that he never did any such thing.

Three members advertised that they were seeking employment, one at $160 per month, and Civil Service had a mining engineering job open at $2100-$2580 per year, about forty per cent of today's scale.

The Officers

J. G. Sullivan, M.E.I.C., of Winnipeg, was the president-elect to be inducted at the annual meeting in Montreal on January 24 and 25, 1922. He had also just been re-elected an alderman of his city. J. M. R. Fairbairn, M.E.I.C., the sitting president, had recently received "an engrossed memento" from the American Railway Engineering Association as a token of appreciation for courtesies extended to the A.R.E.A. during its Montreal meeting of July, 1921.

The agitation over registration seems pretty much to have subsided. There is only a single editorial reference to it in this number of the *Journal* and that quoted from *The Electrician* of London, to some extent questioning its advantages. This quotation must have given quite a fillip to the morale of a substantial number of Canadian engineers who were still not as enthusiastic about the value of registration as were the more vocal proponents of the scheme.

The Winnipeg Branch offered the conclusions of its Committee on Foundations in this *Journal*, which were that there was no uniformity in foundation conditions in Winnipeg, not even very locally. A soil load of 4,000 lb/sq. ft. was recommended as a general maximum, though it was admitted that some buildings had shown no distress at loadings as great as 7,000 lb./sq. ft.

The Lethbridge Branch announced its organization as of December 3, 1921, with S. G. Porter, M.E.I.C., as chairman, C. M. Arnold, M.E.I.C., as secretary-treasurer, and G. N. Houston, M.E.I.C., C. D. MacKintosh, M.E.I.C., and H. W. Meech, A.M.E.I.C., as members of the executive committee.

The city engineer of Peterborough, R. H. Parsons, M.E.I.C., and the Ontario Department of Health were at odds over the type of sewage disposal plant which should be built by the city, so the local Branch expressed its confidence in Mr. Parsons in a resolution published in this *Journal*. It would be interesting to know who won he argument.

Among the thirty-eight applicants for admission to the *Institute* or for promotion to a higher grade, onlv a bare dozen are still members. Thus doth time efface us all.

R. DeL. F.

Elections and Transfers

(Continued from page 54)

G. Martel, R. M. Martin, J. R. G. Martineau, D. Martinoli, R. Martinoli, Y. Masse, C. Melancon, G. Mercier, J. D. M. Morin, L. J. R. G. Morin, G. Neron.

J. G. Niquette, A. Paquette, G. Paquette, F. Paquin, M. Parise, A. Payette, A. C. Pellerin, R. Pelletier, A. R. Penelle, Y. H. Picard, Y. Pichette, A. Placas, R. Plouffe, G. Proulx, J. A. J. Plourde, R. Poirier, R. G. J. Pronovost, R. Provencher, J. E. G. Prud'Homme, C. Racine, J. G. Rene, J. Richard, J. L. J. P. Riel, C. Riendeau, Y. Rivest, F. Roberge, J. P. Y. Rouette, J. M. Roussel, J. C. Roy, J. J. Roy, G. Sauve, G. Scott, J. P. Senay, J. P. Simard, J. Tellier, R. C. Terreault, J. C. Tetreault, D. Tremblay, J. G. Theriault, F. Toutant, D. Tremblay, J. C. Tremblay, C. Tupinier, J. C. S. Trudeau, L. Valiquette.

Applications Through Associations

By virtue of the co-operative agreements between the Institute and the Associations of Professional Engineers, the following elections and transfers have become effective:

ALBERTA

Junior—I. D. Finnan.

Junior to Member—R. B. Kerr, A. L. Stirling.

Student to Junior—D. E. Lee.

SASKATCHEWAN

Members

R. A. Collie, V. L. Moore, J. W. Stevenson, L. F. Swann, J. I. M. Wells.

Students

L. N. Adamache, R. A. Anderson, J. P. Baker, W. M. Beard, M. J. Belak, R. M. Book, G. A. Bowman, R. C. Brewer, R. K. Broeder, J. R. Brooks, C. G. Burns, M. Chorney, M. F. Clark, G. A. Cork, G. F. Cox, S. Dzuba, C. D. Fairburn, F. D. Friedrich, G. G. Galbraith, D. V. Gilewich, R. M. Girling, R. J. Gotts, V. J. Gross, M. M. Hawrysh, E. D. Hoffman, R. C. Holfeld, E. P. Horton, T. E. Huta, D. W. Johnson.

J. A. Kavanagh, H. Keller, R. G. Kessler, N. L. King, G. A. Koss, S. B. Kowalski, A. W. Kruger, R. W. Kyle, R. G. Lloyd, W. D. McKay, W. B. McLean, J. P. Melin, D. A. Meneley, G. Meyrink, J. Molchan, D. E. O'Leary, K. C. G. Pritchard, E. A. Rindt, J. H. Roddick, J. R. S. Sadler, R. B. Snyder, E. L. Steacy, J. J. Syrnyk, R. N. Thompson, A. T. Torgrimson, A. M. Toth, I. S. Turnbull, C. C. Vallance, R. J. Wieser, D. M. Wilson, E. Wiwchar.

Junior to Member—L. S. R. Ely, G. T. Haig.

Student to Junior—J. M. McNeil, K. H. Thompson.

MANITOBA

Member—J. G. Johnson.

Student to Junior—D. D. Elliott.

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§P. M. Sauder, Lethbridge, Alta.
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*S. Sillitoe, Belleville, Ont.
*A. B. Sinclair, Kenogami, Que.
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Secretary, W. L. Dodson, 201 Columbia St., Sydney, N.S.

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Cornwall (Continued)

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Kingston (Continued)

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Montreal (Continued)

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K. C. Graham
J. G. Schaeffer
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Saskatchewan (Continued)

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I. S. Widdifield J. B. Young
A. C. Davidson J. E. Wright
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M. W. Huggins
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% Engineering Institute of Canada,
236 Avenue Road,
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H.Q., North West Highway System,
Whitehorse, Y.T.

Ontario Division

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NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

QUEBEC

Employers of Engineers

Bell Telephone Company of Canada is the largest employer of professional engineers practising in the province of Quebec; as of November 9, 1956, there were 244 P.Eng.'s in Bell's employ in Quebec. Other important employers of Quebec professional engineers are: City of Montreal, 219; Northern Electric Company, 209; Aluminum Company of Canada, 172; Hydro-Quebec, 144.

It is worth pointing out that at one time Bell engineers took their interests in their own hands in drawing to the attention of personnel executives that only competent engineers should be given a title of engineer by the Company. The natural and easiest way to determine who is a competent engineer was to make sure that all company engineers holding a position of professional responsibility at the Bell were legally entitled to do so by being registered with the Corporation of Professional Engineers of Quebec.

Of course the same spirit of professionalism and the same consideration for the engineer's exclusive right to his title exists in other firms as well. For instance, both the City of Montreal and the Quebec-Hydro Commission require that any person who wishes to serve them as an engineer should have his qualifications recognized by the Corporation of Professional Engineers of Quebec and be regularly licensed by it.

Shortage of Engineers

When the president, L. Roy, P.Eng., visited with the members of the Lake St. John region in early October, he had this to say about the shortage of engineers: "For some time now, you have heard about the shortage of engineers attributable to the extraordinary industrial boom of our country in general, to say nothing of the present expansion in the province of Quebec in particular. But how long is this shortage of engineers going to last? This is an extremely important and serious question which confronts the profession

Not that the number of engineers we train in this country is negligible; on the contrary, the number of engineering graduates has been growing considerably, year after year. Our neighbors to the south have recorded a similar increase—the number of engineers as compared with labour has soared from a ratio of 1 to 140 in 1940 to a ratio of 1 to 80 today.

At home as well as in the U.S.A., the number of engineers has grown more rapidly than that of labour and the demand for engineers in industry has skyrocketed. Today, the needs in this field are far from satisfied.

However, the situation is not without remedy, provided we manage to take more advantage of some technical talents now being squandered in jobs that are not connected with the engineering profession as such.

Nevertheless, I feel that if we worry about the actual shortage of engineers today we should not worry too much about the future shortage of engineers. Being naturaly inclined to optimism, I agree with the Financial Post editor, Michael Barkway, who said: "For practical purposes, the next five years count more, there will definitely be a serious shortage and these years will count more than perhaps the next ten. By 1960, we shall have in Canada about a quarter of a million more children between fifteen and nineteen. Probably a larger proportion of them will also be going to university. You can then assume a sharp increase in the supply of engineers from 1961 on. Hang on for another five years, and the worst of our troubles should be over.

And it suggests a word of warning to the young. Shortage in the next few years and the high rates of pay which it causes could go on tempting an increasing proportion of lads to take an engineering courses. So it is by no means impossible that engineers might be in over supply in the 1960's.

It would be a very short-sighted policy on the part of our youth to envisage the problem with only remuneration in view. The real problem is that of training engineers so as to satisfy the demand and to keep abreast of the expanding Canadian industry.

ONTARIO

Engineers in the News

E. Gordon Murphy has been made general sales manager, industrial products with the Linde Air Products Company, Division of Union Carbide Canada Ltd., with the responsibility for all direct user sales of Linde gases, electric and gas welding equipment and supplies. **F. L. Neuman**, has been named general sales manager, special products, covering marketing activities on Union Carbide silicones and Linde crystal products, molecular sieves, rare gases and flame plating.

Robert J. Anderson becomes manager, engineering and sales service with full responsibility for sales engineering and for the operation of Linde sales offices and warehouses, forming part of a staff realignment program of Linde Air Products Company, Toronto. A University of Toronto graduate in electrical engineering, he has for some years held the post of manager, engineering services, for the company. **Richard A. Schmidt** likewise becomes manager, production, with full responsibility for the operation of Linde's eighteen manufacturing establishments across Canada. Mr. Schmidt is a graduate of the University of Notre Dame in chemical engineering and has recently held the position of general superintendent of the organization.

G. E. Lindsay has been made sales manager of the Exide industrial division of Electric Storage Battery Company (Canada) Ltd.

The Exide industrial division will continue to manufacture in its present location on Warden Ave., Scarboro, Toronto, with general offices at 153 Dufferin St., Toronto.

C. E. Marshall has been appointed staff engineer of Automatic Electric Sales (Canada) Ltd., Brockville, Ont. Formerly supervisor of equipment engineering, Mr. Marshall has had wide experience in the design and layout of automatic telephone exchanges and switching systems in Canada. In his new position he will be engaged in field engineering service and will be available for consultation and technical assistance to independent telephone systems.

Bertram A. Wilson has acquired the control of J. A. Wilson Lighting and Display Incorporated of Buffalo, N.Y., and likewise has become its president and general manager.

Dr. A. J. Paszyc has resigned his appointment with H. A. Simons Ltd., consulting engineer of Vancouver, B.C., and has accepted the position of project manager with Ralph M. Parsons Company, 617 South Olive St., Los Angeles 14, Cal.

J. Carl Wilson has acquired control of J. A. Wilson Lighting and Display Ltd., Toronto and becomes president and general manager.

J. R. McGovern has been elected to the position of managing director of Sola Electric (Canada) Ltd., 102 Laird Drive, Toronto 17, Ont. This is a newly formed subsidiary of Sola Electric Co., Chicago, and will market fluorescent lighting ballasts, mercury vapor lamp transformers, dc power supplies, constant voltage transformers and other specialty transformer products.

A graduate in electrical engineering of McGill, Mr. McGovern has been associated with the specialty transformer field in Canada and for the past two years has been district sales engineer for the Sola Electric Company.

J. J. Harris and **C. J. Jamieson** have announced the formation of the firm of Harris and Jamieson, mining consultants. The head office is located at 537 Craig St. West, Montreal, Que., and a branch at Chibougamau, Que., in the Perraylt Building.

W. R. Petri has left the employ of Magor Aviation, Galt, and is now practicing as a consulting engineer in the spheres of aviation, aerodynamics, hydrodynamics, stress analyses, vibration problems and other branches of mechanical engineering.

Mr. Petri has offices at Magor Aviation, Argyle Rd., Galt, Ont., and at 250 King St. North, Waterloo, Ont.

Dr. Maurice Adelman has joined the faculty of Assumption University of Windsor, Ont., as associate professor of chemistry of Essex College.

Dr. Adelman was born in Welland, Ont., and later in 1937 obtained his B.A.Sc. degree in chemical engineering at the University of Toronto. Remaining at Toronto for post-graduate studies he was awarded his Master's degree in 1940 and his Ph.D. in 1946. During the period 1937-45 he was a demonstrator and instructor in the department of chemical engineering.

For the past nine years Dr. Adelman has conducted his own business as a consulting chemical engineer under the name "Starkman Analytical Laboratories". Last year the firm's name was changed to "Adelco Laboratories". Apart from his consulting work he has published articles of a general scientific nature as well as some devoted to chemical research in technical journals. He has also developed several patents.

J. H. Bleaney is employed in the engineering department of the Township of North York as roads engineer.

Hugo Vajk, Jr. is resigning from his position of assistant to the president of Standard Iron and Steel Works Ltd., Toronto, to move to New York, to join the Joy Manufacturing Co. Export, 60 East 56th. St., New York 22.

W. Alex Shaw, chief engineer of the hydro division, The Windsor Utilities Commission, Windsor, Ont., retired on November 1, after thirty-six years' service with Hydro in Windsor. He is now living in Clearwater, Fla.

Mr. Shaw obtained his degree in engineering from Queen's University, Kingston, in 1921, his course being broken by service during World War I. He joined the Windsor Hydro in May, 1920.

C. S. Purser of the Department of Transport of Canada, has moved to St. Catharines, Ont., where he is assistant superintending engineer, Welland Canal.

Charles H. Gerenraich of St. Thomas, Ont., has been elected president of the Kiwanis Club of that city. G. Duncan Black, has been appointed to the executive of the same organization for 1957.

Donald C. Redpath has moved to Boston, Mass., where he is employed with the research and advanced development division of Avco Manufacturing Corp., 750 Commonwealth Ave.

David H. Clegg, formerly with the DuPont Co. of Canada Ltd. in Montreal, is now a process engineer at the Port Alice, B.C., mill of the Alaska Pine and Cellulose Co. Ltd.

D'Arcy B. G. Dutton has succeeded Ernest E. W. Oke, as city engineer of Waterloo, Ont. While Mr. Oke has retired from his city engineer's responsibilities, he is continuing in consulting and advisory work.

Mr. Dutton graduated in civil engineering from the University of Manitoba in 1949 and for the three ensuing years was a field engineer in the engineering department of Port Arthur, Ont. In 1952 he was appointed assistant township engineer for the Township of Etobicoke, Ont. and a little over a year ago he moved to the Waterloo engineering department, first serving as assistant city engineer and since last April as deputy city engineer.

Harvey F. Hurlbut has moved from London, Ont. to Manitoba where he is the assistant brewmaster of The Kiewel Brewing Co. Ltd. in St. Boniface, Man.

Donald Blackburn of Martin Paper Products Ltd., a subsidiary of the Powell River Company, has been appointed to the head office staff as director of production. He was formerly production manager at the company's Winnipeg plant.

Mr. Blackburn, who graduated in 1948 in engineering and business from the University of Toronto, was in the management consulting field before entering the corrugated paper box industry in 1953.

P. C. Toft, who was previously on the engineering staff of Imperial Oil Ltd., at Sarnia, Ont., is employed with the Canadian General Electric Co. Ltd., Peterboro, Ont., in the atomic power department.

D. E. McGregor and **C. E. Beynon** inform us that the firm of McGregor and Beynon Ltd., consulting engineers, have moved to new and larger premises at 2510 Yonge Street, Toronto 12, Ont. The telephone number is HUdson 1-5688.

Norman F. Parkinson will retire at the end of this year, as executive director of the Ontario Mining Association and the Mines Accident Prevention Association, which offices he has held since 1942. He is taking up residence in Victoria, B.C.

In referring to the retirement, M. L. Urquhart, president of the Ontario Mining Association stated: "We in the mining business in Ontario feel a great sense of loss through Mr. Parkinson's well-earned retirement. He has made an extraordinary contribution to the industry and to Canada as a whole."

Mr. Parkinson graduated in engineering from the University of Toronto. Following service with the Canadian Field Artillery in World War I, he became director of Veteran's Training in 1919 and the next year was appointed deputy minister of the Department of Soldiers' Civil Re-establishment. In 1927 he resigned his post to supplement his Master's degree in civil engineering with geological studies. Until assuming his recent position with O.M.A., he was engaged in the mining field, being the first secretary-treasurer of Ventures Ltd., and holding offices and directorates in a number of other companies, including Falconbridge Nickel and Fahralloy Canada Ltd.

Hudson Mossop, formerly chief engineer of the Sterling Electrical Company Limited, St. Catharines, Ont., has been appointed vice-president and general manager of the company. He is also a graduate of the University of Toronto, class of 1949.

E. L. Dodington has been named president of the Sterling Electrical Company Limited, St. Catharines, Ont. Previously vice-president and general manager, he is a 1938 graduate of the University of Toronto.

John Beattie, manager of Delnite Mines Ltd., Timmins, Ont., has resigned this position to take up the duties of executive director of the Ontario Mining Association, Toronto. He succeeds Norman F. Parkinson, who retires from the post December 31, 1956.

Mr. Beattie obtained his B.A.Sc. in

mining engineering at the University of Toronto in 1924 and in the following year was awarded his Master's degree. In 1925 he joined McIntyre-Porcupine Mines, subsequently becoming manager of Delnite Mines with which he has been connected for a number of years.

Eber A. Pollard, assistant chief engineer of Federal Wire and Cable Company Limited, Guelph, Ont., has been appointed chief engineer in place of R. G. Oldham, now in England.

Mr. Pollard is a graduate in engineering physics of the University of Saskatchewan and following his graduation in 1941 worked for the National Research Council, first at the University of Toronto in conjunction with the RCAF on equipment for high altitude flying, and later in Montreal on the atomic energy project. In 1945 he joined the engineering research department of the Massey-Harris Co., and later transferred to the engineering department where he became assistant to the chief engineer, tractor section. In 1950 he joined Federal Wire and Cable.

A. V. W. Stenson, is now employed as an electrical engineer in the Directorate of Engineer Development, Department of National Defence, Elgin Annex, Elgin Street, Ottawa, Ont.

W. J. Fletcher, has resigned from his position as electrical design engineer with the Canadian General Electric Company Limited, to assume the post of chief engineer of the power equipment development section on the staff of the electrical engineer-in-chief, Royal Canadian Navy, Ottawa, Ont.

R. M. Gair, of the British American Oil Co., Ltd., is now a process engineer in the manufacturing engineering department of the company at 800 Bay Street, Toronto.

BRITISH COLUMBIA

Association's Annual Meeting

A record number of newly registered engineers, eighty-five in all, were presented with certificates at this year's annual meeting of the Association of Professional Engineers of B.C., held at the Hotel Vancouver, November 30 and December 1.

In addition, two professional engineers received Life memberships in the Association and a number of special prizes and awards were made to engineering pupils. The presentations took place at the Association's annual awards luncheon on Friday, November 30.

Seventeen Victoria engineers were also eligible for certificates of registration and one for Life Membership. Presentations to these members was made at the annual meeting of the Victoria branch of the Association, held November 22.

Guest speaker at the two-day annual meeting of the Association was Paul H. Robbins of Washington, D.C., executive director of the National Society of Professional Engineers in the United States. Widely known throughout Canada and the United States as a capable, interesting speaker, Mr. Robbins was able to draw upon a long and varied engineering career for material. He addressed a luncheon meeting Saturday, 1 December.

Life memberships will be presented to R. T. Blair, Vancouver, and E. H. Orser, Vancouver, at the awards luncheon. Winners of the Ingleow prize awards, announced earlier this year, will be introduced at the meeting. The awards presented annually to the outstanding student in each year of the engineering courses at U.B.C., were won by Kenneth Charles Wilson, Todd Garrett, and George Alexander Wilson, all of Vancouver. The fourth winner, J. J. F. Loewen of Vancouver is attending Harvard University and will be unable to attend the meeting.

Winners of the annual Association of Professional Engineers of B.C. book prizes, presented each year to the third year U.B.C. engineering students writing the best summer essay in each branch, was presented at the meeting. They are Egon J. P. Matzen, Vancouver, (Chemical); Gary S. Grais, Vancouver, (Civil); Malcolm M. McKenzie, Vancouver, (Electrical); Gordon Mah, Vancouver, (Mechanical); and George C. Wooton, Vancouver, (Metallurgy).

The Association's new executive, elected during the convention, were installed on Saturday evening at the close of the convention. Following the final session, members and their wives attended a dinner dance in the hotel ballroom. Music was supplied by Dal Richards.

Engineers in the News

R. C. Pybus, has been named president and general manager of Commonwealth Construction Co. Mr. Pybus, who had been director and Western manager of the company, was also recently elected vice-president of the Canadian Chamber of Commerce.

F. J. Dwyer has joined the Vancouver Branch of Canadian Johns-Manville Co. Ltd. in a sales capacity to serve the plumbing and heating trade. Mr. Dwyer was previously with Blain Boiler Works as sales manager.

J. S. Kendrick of the Aluminum Co. of Canada, has returned from Montreal and has taken up residence at Kitimat.

Eric Anderson, previously with the B.C. Engineering Co., is now with the B.C. Power Commission in Victoria.

J. A. Eddleston, formerly residing in North Vancouver, is now in Kelowna with Kelowna Bridge Contractors Ltd.

R. C. B. Henderson has resigned his post with the Aluminum Company of Canada and has taken a position as senior office engineer with the International Engineering Company of San Francisco. He is presently in East Pakistan on a hydroelectric project.

D. G. Tapley who was with Electric Power & Equipment Ltd. in Vancouver is now in Bellevue, Wash. He is working for the Boeing Airplane Co. at their Renton plant.

L. W. Locke is now employed as an electrical design engineer in the transport division of the Boeing Airplane Co., of Seattle, Washington. Mr. Locke had been in Nanaimo as maintenance engineer with the B.C. Power Commission.

R. J. Pinder recently left the employment of Crown Zellerbach Canada Ltd. at Ocean Falls and is now employed with MacMillan & Bloedel (Alberni) Ltd., Alberni Pulp & Paper Division.

Keith Wallis is now with the B.C. Engineering Co. as supervisor station electrical design. He had been with the consulting firm of Simpson & McGregor.

R. H. Johnston is now with Jeanette Minerals, Santiago, Cuba.

Hugh Coleopy has accepted a position with Canadian Forest Products, Howe Sound Pulp Division, at Port Mellon. Mr. Coleopy was previously with the Gas Production Department, B.C. Electric, in Vancouver.

R. H. Ansley, assistant Pacific manager of Commonwealth Construction Co., was recently appointed a director of the company.

A. R. Shrumm has accepted a job with the Boeing Airplane Co. in Seattle, Washington. He had been in Vancouver working for the Department of Public Works.

A. J. Paszyc recently accepted the position of project manager with Ralph M. Parsons Company of Los Angeles. Dr. Paszyc has been project engineer with H. A. Simons Ltd. in Vancouver.

R. S. Taylor is now with the engineering and board of works departments of the City of Trail. Mr. Taylor, a 1951 civil graduate of U.B.C. relinquished a position in municipal works at Kitimat in order to accept his new appointment.

M. Chercover, previously with J. L. Miller, consulting engineer, is now with Western Canada Steel.

G. F. Winterburn, until recently, with the Bay Co. (B.C.) Ltd., is now mechanical engineer in charge of construction for the Electric Reduction Company of Canada Ltd.

E. H. Tarrant has accepted a position with Canadian Collieries (Dunsmuir)

(Continued on page 63)

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Frederick Percy Shearwood, President, 1934

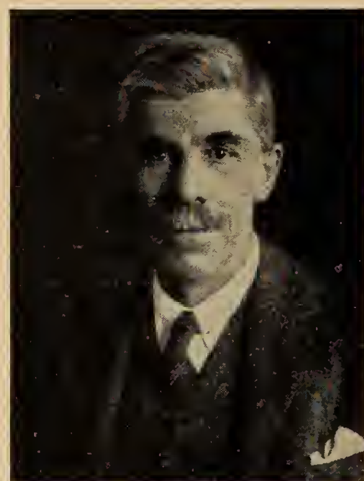
Frederick Percy Shearwood, HON.-M.E.I.C., retired chief engineer with the Dominion Bridge Company Limited, Montreal, and past president of the Institute, died on November 22, 1956, at Montreal.

From London, Eng., he was born there on November 2, 1866. After an engineering education received through private tuition, he went to Brazil in 1884 to work as a junior engineer for the Sao Paulo Railway Company. Three years later, in 1887, he came to Canada to begin his long and noteworthy career in this country, with Dominion Bridge Company Limited, Lachine, Que. Appointed chief engineer in 1921, he became a consulting engineer with the firm in 1937. Finally, in 1948, he retired from active professional duties.

Widely known in engineering circles for his part in the design and erection of a number of the important bridges and other structures in Canada, in 1955 he was, in his ninetieth year, awarded the Gzowski medal of the Institute for the best paper of the year on a civil engineering subject. He was a 1935 winner of the King's Jubilee Medal.

Memorable as a yachtsman and yacht designer, Mr. Shearwood was associated with G. H. Duggan, M.E.I.C., for ten years in building and racing the boats which brought the Seawanhaka cup to Canada, and for nine years, during the eighteen eighties and nineties, successfully defended that trophy. Adding to his skill in this field as in the field of structural design and erection, Mr. Shearwood was responsible for many other successful yacht designs. He was a life member of the Royal St. Lawrence Yacht Club.

Always an active member of the Institute, he became an Associate Member in 1892 and transferred to member in 1904. Elected to Council in 1909 and again in 1921-23, he was vice-president from 1923 to 1925 and chairman of the finance committee at the same time. Treasurer of the Institute in 1926, he held that office until 1930. He was elected president of the Institute for the year 1934. Honorary membership was conferred on him in 1953. He was a member of the American Society of Civil Engineers, the American Railway Engineering Association and the Corporation of Professional Engineers of Quebec. He also served on various committees of the Canadian Engineering Standards Association.



F. P. Shearwood, Hon. M.E.I.C.

Henry Augustus Dupre, M.E.I.C., retired official of the Electricity and Gas Inspection Department of Trade and Commerce, Ottawa, died in August, 1956.

Born in London, Eng., on September 6, 1877, Mr. Dupre studied civil and mechanical engineering at the Associate City and Guilds of London Institute, which is now London University. He also followed studies in Germany.

Beginning his engineering career in 1901 he was associated with the firm of Armstrong Whitworth and Company, Newcastle on Tyne, where he was in charge of the electrical testing department for a period of five years. He was also engaged for a time in perfecting the auto electric cab signalling system on the Great Central Railway.

In 1913 Mr. Dupre was appointed assistant to the chief engineer with the Department of Inland Revenue, Ottawa. However, he spent the war years overseas, returning to his duties at Ottawa in 1919 in the position of acting assistant director of electricity and gas inspection.

Elected a Member of the Canadian Committee of International Electro-Technical Commissions and the Incandescent Lamp sub-committee of Canadian English Standards Committee in 1920, he was also named assistant director of Electricity and Gas Inspection, with the Department of Trade and Commerce at that time.

Mr. Dupre joined the Institute in 1914 as an Associate Member and transferred to Member in 1920. He attained Life membership in 1944.

Norman Leroi Crosby, M.E.I.C., retired engineer with the Hamilton Bridge Company Limited, died suddenly at Ancaster, Ont., on November 1, 1956.

A maritimer, Mr. Crosby was born at Hebron, N.S., on August 15, 1880. He enrolled in an arts course at Acadia University in 1899 and then went on to a civil engineering course at the School of Practical Science in 1902. He was awarded the degree B.A.Sc. at the University of Toronto in 1906.

Chief draftsman with the Halifax and Eastern Railway on graduation, he had also taken part in the construction of the Halifax and Southwestern Railway and worked with the Dominion Bridge Company while still a student. In 1908 Mr. Crosby went on to design and estimating work for the firm of McClintic-Marshall Construction Company, Pittsburgh. He became associated with the Hamilton Bridge Company in 1923, working as a district representative in Toronto. In his latter years with the firm he had been located at Hamilton and engaged in sales engineering work. Active in the organization for thirty years, Mr. Crosby retired early in 1954.

A Student member of the Institute in 1902, Mr. Crosby was transferred to Associate Membership in 1909 and became a Member of the Institute in 1940. He attained Life membership in 1949.

John Starley Lochhead, M.E.I.C., administrative engineer and director of Racey-MacCallum and Associates Limited, consulting engineers of Montreal, Toronto and Vancouver, died in an automobile accident at Lancaster, Ont., on November 14, 1956.

Born in Montreal on December 26, 1913, he was educated at McGill University where he obtained a B.Eng. degree in civil engineering in 1937. At the beginning of his career employed with Dominion Bridge Company, Montreal, he also had experience with Defence Industries Limited, during the war years, and with Canadian Vickers Limited, aircraft division. He served as a planning engineer with Canadair Limited, Montreal, in 1945.

An independent consultant and manufacturers agent for five years, he was appointed Canadian director of Consulting Designers for Industry, Inc., Cleveland, Ohio, and was also associated with the Montreal firm of McDougall and Friedman as consulting engineer during this period. Later he held the position of sales engineer and special projects engineer for Charles, Warnock and Company Limited.

One of the founders of the firm of Racey, MacCallum and Associates, in 1952, he was elected a director and appointed a vice-president. Until a recent transfer brought him to Montreal, Mr. Lochhead had been responsible for the Vancouver operations of the firm. He then took on the additional duties of administrative engineer, which duties he performed until the time of his death.

Mr. Lochhead was a member of the Association of Professional Engineers of Quebec, Alberta, and British Columbia.

He joined the Institute as a Student member in 1934, transferred to Junior in 1941 and was elected a Member in 1945.

Aurel G. Jarry, M.E.I.C., president of Jarry and Frere Ltee, Montreal, died in Montreal on November 2, 1956.

A native of Montreal, Mr. Jarry was born there on January 11, 1916. He received his engineering training at McGill University, graduating with a B.Eng. degree in civil engineering in 1940. He was also a graduate of the Royal Military College, Kingston, Ont., class of 1938.

Beginning his graduate career as a navigation instructor in the R.C.A.F., in 1940, he later served overseas as a pathfinder navigator in the closing year of the war.

In 1947 Mr. Jarry became co-proprietor, service manager and industrial division manager for the firm of Jarry and Frere, Montreal. His appointment as president was made in May of this year.

A student member of the Institute in 1940, he transferred to Junior in 1943 and became a Member in 1949.

Joseph Henry Hamel, AFFIL.E.I.C., retired president of the Provincial Paint and Supply Company, Montreal, died in Montreal on November 20, 1956.

A native of Quebec City, Que., he was born on November 2, 1887, and received his education at St. Dunstan's University, P.E.I. In 1903 he was awarded a bachelor of arts degree followed by a bachelor of science degree in 1905.

Associated with the Canadian National Railways for the first six years of his career, Mr. Hamel later worked for the Department of Marine and Fisheries, Province of Quebec, for three years. He served with the Canadian Army from 1915 to 1918. The following year he returned to his position with the Province of Quebec. In the ensuing years, until 1936 he was also associated with the C.N.R., at Edmunston, N.B., and with the Quebec Harbour Commission. He joined the Department of National Defence at Valcartier in 1939, and held a position as superintendent and engineer for the Department at Lauzon, Que., in 1941. He served in the same position for E. G. M. Cape and Company of Montreal in 1942 on National Defence work at St. John's, Nfld. In 1945 he held the appointment of engineer and inspector general of the Department of Roads, Province of Quebec.

Mr. Hamel's association with the Provincial Paint and Supply Company, Montreal, dates to 1951. He joined the firm at that time as vice-president and general manager, becoming secretary in 1953 and president of the organization in 1955.

He joined the Institute in 1942.

NEWS OF THE ASSOCIATIONS

(Continued from page 61)

Ltd. Mr. Tarrant had been on the electrical engineering staff of H. A. Simons Ltd.

Dennis Duncan, an engineering pupil, won a Dow Chemical of Canada Scholarship of $500 awarded to a student entering final year of chemical engineering.

J. C. Taylor of Kamloops, an engineering pupil, won the Heavy Construction Scholarship of $250 for civil engineering.

R. F. Heckman, previously with Western Consulting Ltd., is now working with the B.C. Engineering Co. as a designer.

A. P. Martinez, formerly with Cemco Electrical Manufacturing Co. has accepted the position of chief engineer of Johnson & Phillips Ltd., manufacturers and distributors of electrical equipment.

F/O H. P. Burden, now with the R.C.-A.F., has been transferred from Camp Borden to the big armament base at Cold Lake, Alberta.

ALBERTA

Unity — Confederation

Reprinted from "Presidentialities" — in the November issue of The Alberta Professional Engineer.

"The Plan for Unity" and "Confederation" are two phrases that are being discussed by many professional engineers today, both in committee and in any place where two or more of them may meet. All who discuss the proposal appear to be in favour of it as I have yet to hear of one who is not just a little anxious to see it move forward as quickly as possible.

Herbert J. Smith of the Association of Professional Engineers of Ontario, is the author of the "Plan for Unity" as we know it today. The Engineering Institute of Canada refers to the subject as "Confederation". Both titles have been used, in all of the discussions that I have heard, synonymously. You too, may have heard something like this: "Plan for Unity — Confederation? It doesn't matter what you call it you know what we mean. We only wish they would get along with the job. It's been talked about long enough, now let's hear of some action."

It would seem to me that the only thing that all of us are discussing is the desirability of having one Engineering Organization in Canada that would, in short, take over the roles of both Dominion Council and the Engineering Institute. The general way in which this is to be done has not been discussed by many, other than those on the committees set up to do that job.

The two titles have essentially different meanings and suggest to me that two different types of a National Organization could result, depending on which title is accepted. Just which one is decided upon depends on you and I. Hence I believe that we should consider the implications of each title.

Unity among the Professional Engineers of Canada will mean one new National Organization in which the identities of our present bodies will be submerged. The individual organizations would disappear completely in favour of one new one that would carry on all of the phases presently covered, plus any new ones that are possible through such unity. The actual organization is more than likely to be different to any one now existing.

Confederation on the other hand suggests that existing groups will combine into a National Organization while still retaining a great deal of their original identities. The individual organizations might not completely disappear and the various functions would continue much as they do now. Here are examples of the two results. Unity might result in the formation of a new headquarters in Ottawa, staffed by a relatively small group, financed by national fees collected and rebated by the provincial bodies, and responsible for the overall operation of the organization under a national council. A national professional publication might be their responsibility also. The provincial bodies might finance and operate the branches.

Confederation could result in the retention of the present headquarters in Montreal along with the Engineering Journal in its present form, the library and the employment service. Financing of the branches and their control could also remain with it. The national fees would be a larger rebate from the Provincial bodies so that a rebate could be returned to the branches. This larger staff would also be responsible for the operation of the organization under a National Council.

With these two brief examples before you I hope that you will recognize the possibilities in the formation of a National Organization. You may like one or the other, or even perhaps you have no preference. Whether you have a preference or not for either of these examples or for a compromise of the two, I hope only that you will think about the question and discuss it with others so that when you are asked to decide you may know whether you want "Unity" or "Confederation".

Personals

News of the Personal Activities of Members of the Institute.

Dr. R. L. Hearn, M.E.I.C., chairman of the Hydro Electric Power Commission of Ontario, has retired from office. Continuing his service to Hydro as a consultant, however, he intends to establish a private engineering practice.

The long and notable engineering career of Dr. R. L. Hearn began in 1913 when he graduated from the University of Toronto. Briefly with the City of Toronto roads and works department and Dominion Bridge Company Limited, he had by 1921 attained the post of assistant engineer of construction for the Commission, on a hydro-electric power plant. At one time the world's largest, this plant is now known as the Adam Beck-Niagara Generating Station No. 1. Positions with the Washington Power Company, Spokane, as assistant chief engineer, and with the firm of H. G. Acres Company Limited, St. Catharines, Ont., as chief engineer and secretary-treasurer followed, in the nineteen-twenties. During the early period of the next decade he earned the position of consulting engineer for Dominion Construction Company and H. F. McLean Limited and continued as chief engineer with the firms until 1942.

Returning to the Commission in 1942 as an executive assistant to the chairman, his services, in demand elsewhere during the war years, were loaned to the Polymer Corporation's synthetic rubber plant at Sarnia. Chief engineer in charge of construction there, he was later in 1944 asked to serve as Canadian technical advisor to the Public Utilities Division of the Combined Production and Resources Board at Washington, D.C. At war's end, returning to the Commission, he assumed the duties of engineer of design and construction. Named general manager and chief engineer in 1947, his appointment as chairman of the Commission was announced early in 1955.

A member of many technical organizations in Canada, the U.S. and Great Britain, Dr. Hearn was in 1952 appointed a director of Atomic Energy of Canada Limited. Also in 1952 he was awarded an honorary degree of Doctor of Engineering by the University of Toronto. In 1955 the Engineering Institute awarded him the Julian C. Smith Medal for achievement in the development of Canada.

On many occasions openly acclaimed for his contribution to Ontario's publicly owned hydro enterprise and the Canadian engineering field, he was given lasting recognition in 1951 when Canada's largest fuel-electric power plant, the Richard L. Hearn Generating Station, was named in his honour.

In the period of more than forty years since first joining the commission, Dr. Hearn has played a major part in the growth of the organization, with its unprecedented power expansion program, embracing major hydro-electric projects and Canada's largest steam generating installations.

Dr. Hearn joined the Institute in 1920 as an Associate Member.

G. R. Connor, M.E.I.C., and **C. B. Jackson,** M.E.I.C., of Alchem Limited, have been jointly appointed to the position of assistant vice-president. In the service of the company for more than fifteen years, in the field and home office, their most recent positions were those of managers of the industrial and production departments, respectively.

Mr. Connor joined Alchem in 1939, with a B.A.Sc. degree in chemical engineering, gained at the University of Toronto.

Mr. Jackson graduated from the University of Saskatchewan in 1931 with the degree of B.Sc. in civil engineering. He joined the staff of Alchem in 1941 and has since then held positions as district engineer, resident engineer and plant engineer with the organization.

G. R. Connor, M.E.I.C.

C. B. Jackson, M.E.I.C.

J. G. Notman, M.E.I.C., president of Canadair, has recently been elected a director of the Crown Trust Company and has accepted the presidency of the Air Industries and Transport Association. He is senior vice-president of Canadair's parent company, General Dynamics Corporation, New York; chairman of the board of Atlas Copco Canada and S. F. Products Limited; a director of the Canadian Bank of Commerce, Canadian Marconi, Montreal Locomotive Works, Canadian Arsenals Limited, Canadian Industrial Preparedness Association and the Quebec Industrial Relations Institute.

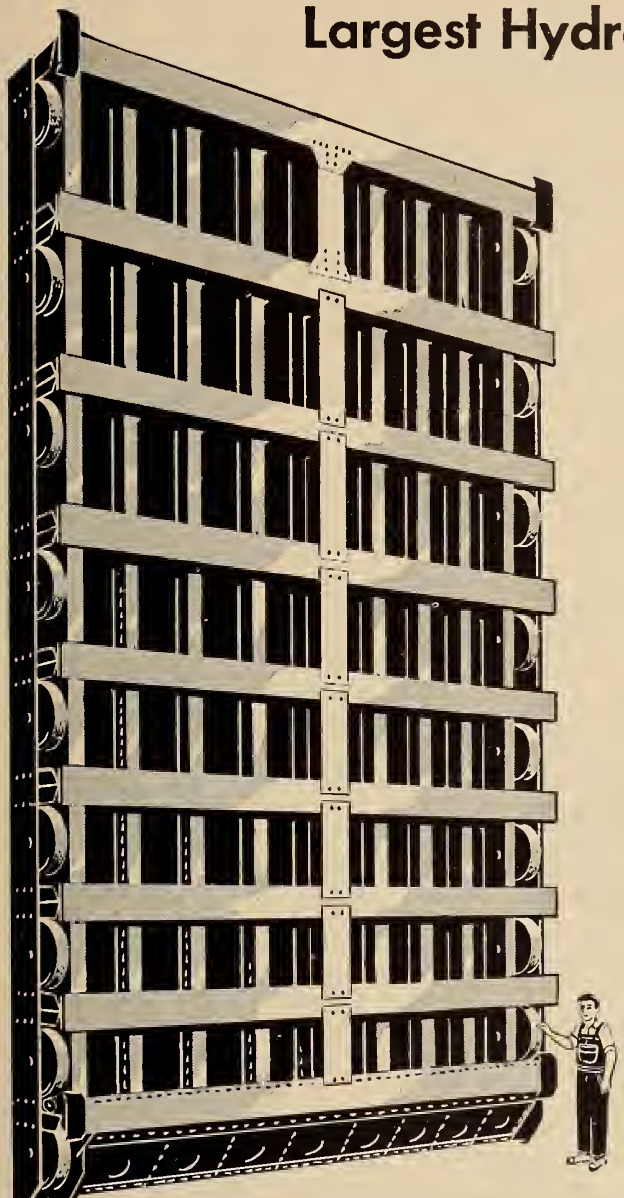
D. B. Steinman, M.E.I.C., consulting engineer, New York City, has been retained by the government of Iraq to design and supervise the construction of a suspension bridge over the Tigris River in Baghdad. It is estimated to cost $5,000,000.

G. A. Cunningham, M.E.I.C., has been named assistant manager of the technical services and transferred to the head office staff of Imperial Oil Limited, Toronto, Ont.

Formerly located at Halifax, N.S., Mr. Cunningham took an active part in the affairs of the Institute, and was chairman of the Halifax Branch at the time of his recent appointment.

W. H. Price, M.E.I.C., formerly assistant general manager of Mid-Western Industrial Gas Limited, Edmonton, has been appointed general manager of the company.

Mr. Price joined Mid-Western in 1952 as chief engineer. He is a graduate in chemical engineering from the University of Alberta in 1949.



Largest Hydraulic Regulating Gate Order Ever Placed in Canada

Illustrated at left is a scale drawing of one of 48 head gates for the Canadian section of the Barnhart Island Power House — a part of the St. Lawrence power project.

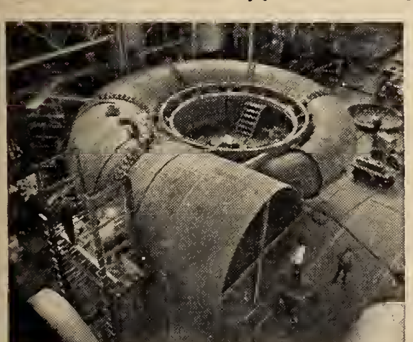
These gates comprise the largest order of the kind ever placed in Canada and are now being fabricated for Ontario Hydro. With bedded parts and hoists, they are designed by Dominion Bridge for 17 ft. wide by 37 ft. high openings. Each will withstand a pressure of 3,000,000 lbs. with 93 ft. head at sill.

By its association with most of the large power projects built in Canada, Dominion Bridge has accumulated a wealth of experience, making it a leading authority in this specialized field.

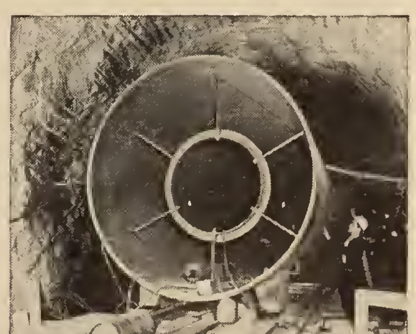
Plants at: MONTREAL, OTTAWA, TORONTO, WINNIPEG, CALGARY, VANCOUVER. Assoc. Company Plants at: AMHERST, N.S.: Robb Engineering Wks., Ltd. QUEBEC: Eastern Canada Steel & Iron Wks., Ltd. SAULT STE. MARIE: Sault Structural Steel Co. Ltd. WINNIPEG: Manitoba Bridge & Eng. Wks. Ltd. CALGARY: Riverside Iron & Eng. Wks., Ltd. EDMONTON: Standard Iron & Eng. Wks., Ltd.

DIVISIONS:
Structural • Platework • Mechanical • Boiler • Warehouse.

Typical examples of Dominion Bridge work for other Hydro Projects.



Welded scroll case



Penstock lining

60-ton headworks gantry crane

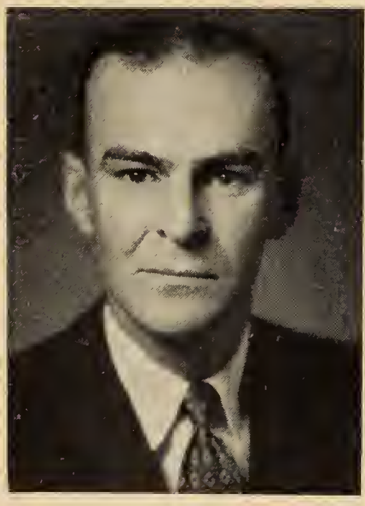
DOMINION BRIDGE COMPANY LIMITED

• PERSONALS

S. D. Cavers, M.E.I.C., formerly research engineer with the B.C. Research Council, now holds the position of associate professor of chemical engineering at the University of British Columbia.

Mr. Cavers is a University of British Columbia graduate in chemical engineering, class of 1942. He became employed with the University of Saskatchewan as an associate professor of chemical engineering in 1952.

J. A. Beauchemin, M.E.I.C.



W. H. Beaton, M.E.I.C.

Jules Armand Beauchemin, M.E.I.C., has announced an expansion in the Montreal firm of J. A. Beauchemin and Associates, in the formation of a partnership to include W. H. Beaton, M.E.I.C., H. Lapointe, M.E.I.C., R. O. Beauchemin, M.E.I.C., and P. T. Beauchemin, JR.E.I.C., who will carry on the practice of the consulting engineering firm under the new name of Beauchemin-Beaton-Lapointe.

A past-chairman of the Montreal Branch of the Institute, Mr. Beauchemin is also a past-councillor representing the Montreal Branch, and a past-president of the Alumni Association of Ecole Polytechnique.

W. H. Beaton, M.E.I.C., an associate in J. A. Beauchemin and Associates, consulting engineers of Montreal, has become a partner in the firm, Beauchemin-Beaton-Lapointe.

Mr. Beaton is a graduate in civil engineering of McGill University, class of 1947, and has since been occupied in the consulting field.

H. Lapointe, M.E.I.C., an associate in J. A. Beauchemin and Associates, consulting engineers of Montreal, has become a partner in the firm, renamed Beauchemin-Beaton-Lapointe.

Mr. Lapointe graduated in civil engineering from McGill University in 1951, and has since been occupied on consulting work in the field of municipal engineering.

R. O. Beauchemin, M.E.I.C., of J. A. Beauchemin and Associates, consulting engineers of Montreal, has become a partner in the firm, Beauchemin, Beaton-Lapointe.

Mr. Beauchemin graduated from the Ecole Polytechnique in 1950, and was previously with Canada Cement Company Limited.

P. T. Beauchemin, JR.E.I.C., of J. A. Beauchemin and Associates, consulting engineers of Montreal, has also become a partner in that firm.

A. C. Dalrymple, M.E.I.C., has accepted a position as civil engineer, class II, in the power development division of the B.C. Power Commission, Victoria, B.C.

Earlier this year, Mr. Dalrymple, who is originally from Great Britain, was employed as a structural design engineer with Standard Iron and Engineering Works, Edmonton.

W. W. Brumby, M.E.I.C., has accepted employment with Malartic Gold Fields Limited, at Halet, Que., where his position is that of mechanical and electrical superintendent.

Mr. Brumby was associated with the English Electric Company of Canada Limited at St. Catharines, Ont., for a number of years, and has served the Canadian Westinghouse Company Limited, at Winnipeg, since 1952.

In 1945 Mr. Brumby was a member of the British Admiralty Technical Mission at Ottawa.

Allan W. Gilmour, M.E.I.C., has left the employ of the Powell River Paper Company of Canada and is employed as an electrical engineer with Machinery Designers Incorporated, at Hoquiam, Washington, U.S.A.

An Edinburgh University graduate, class of 1948, Mr. Gilmour was formerly associated with the B.C. Electric Company Limited, at Victoria, B.C. shortly after coming to this country.

Major K. F. Collins, M.E.I.C., has left the appointment of officer commanding, armament company, R.C.E.M.E. school at Barriefield, Ont., and has been appointed general staff officer, grade II, with the directorate of weapons and development, at Army headquarters, Ottawa.

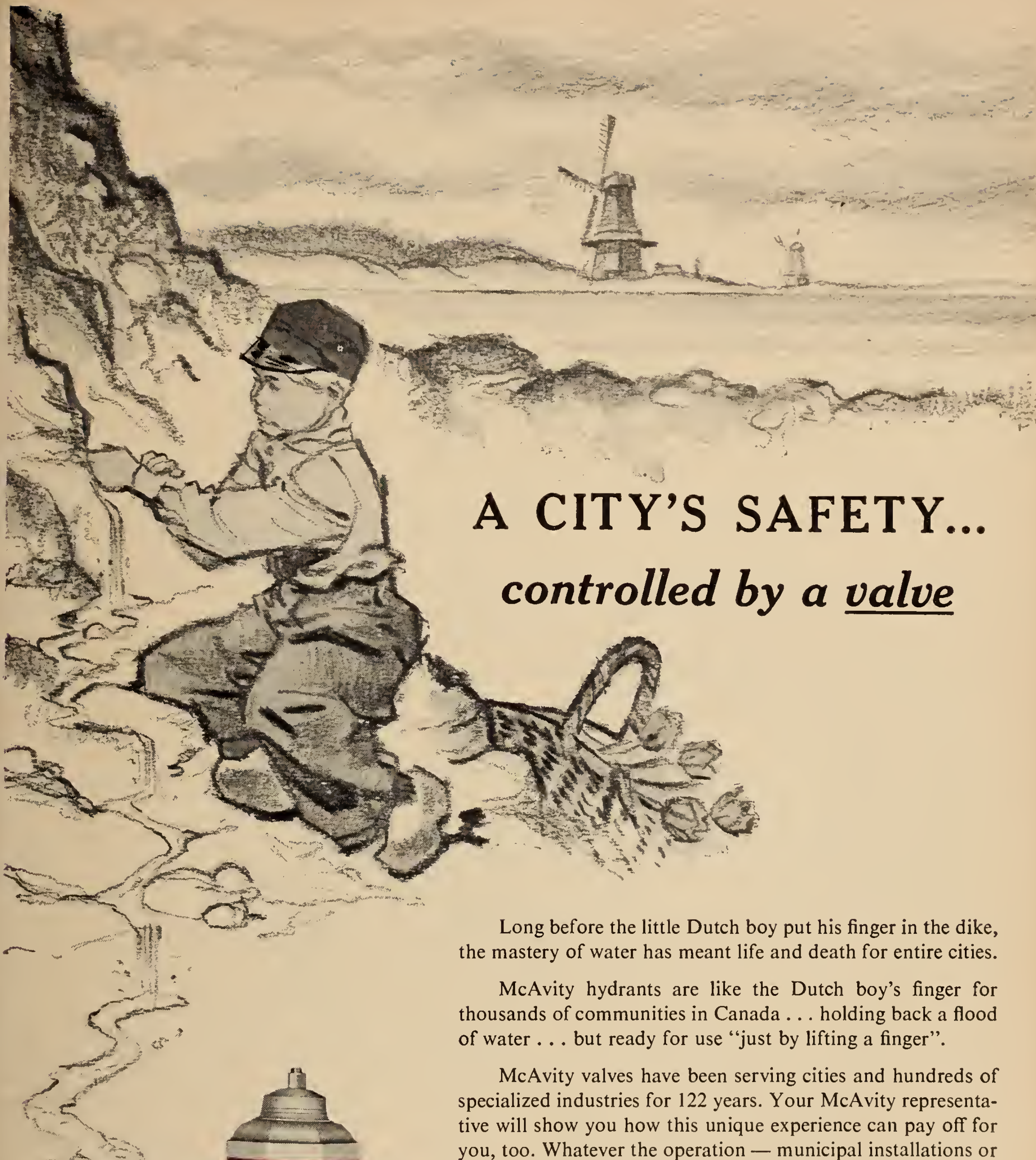
Major Collins is a 1941 graduate of Queen's University, in chemical engineering.

C. T. Aitken, M.E.I.C., has accepted a position with the American Flange and

H. Lapointe, M.E.I.C.

P. T. Beauchemin, JR.E.I.C.

R. O. Beauchemin, M.E.I.C.



Manufacturing Company, Inc., at Linden, N.J.

Mr. Aitken was formerly planning engineer in the special contracts department of the Bell Telephone Company, at Montreal.

L. J. Macdonald, M.E.I.C., of Montreal, superintendent of rolling stock with the Montreal Transportation Commission, Montreal, since 1946, has resigned from office. He has accepted an appointment as general manager of the Ottawa Transportation Commission, Ottawa, Ont.

Beginning his career in Canada at the conclusion of World War II, Mr. Macdonald brought with him sixteen years' experience in the field of mechanical engineering. This includes responsibility with the Corporation Transport of Aberdeen, Scotland, 1930-35, and a period of four years as a supervisor concerned with high speed experiments on road, rail and marine diesel engines, with the Associated Equipment Company, Middlesex, Eng. After six years' war service Mr. Macdonald retired from the R.A.F. with the awards of D.F.C. and Bar, and D.F.M.

W. J. Dyck, M.E.I.C., who was in 1955 at work with the General Petroleum Corporation, Torrance, Calif., has taken a position with Hydrocarbon Research Inc., New York. He will be stationed at Duesseldorf, Germany as project engineer.

With Hydrocarbon Inc., in Germany at an earlier date in his career, in 1952, he has also held positions with the Lummus Company, N.Y., as process engineer and with the British Columbia Research Council, Vancouver, as a chemical engineer.

Mr. Dyck graduated from the University of Saskatchewan, class of 1942.

G. D. Zimmerman, M.E.I.C., has been elected president and general manager of the firm of Fischer and Porter (Canada) Limited, at Toronto.

Previously vice-president and managing director of the company, Mr. Zimmerman joined Fischer and Porter Company of Hatboro, Pennsylvania, in 1946, in the capacity of sales engineer. The following year he opened the first office for the U.S. Company in Montreal, with the subsequent incorporation of the Canadian company in 1949.

Mr. Zimmerman is a graduate of the University of Toronto in chemical engineering.

Larry Murphy, M.E.I.C., distribution engineer with Ferranti Electric Limited, has recently been appointed maritime district manager for the organization.

Mr. Murphy graduated with a B.Eng. degree from the Nova Scotia Technical College in 1949 and after a two-year training course joined the Nova Scotia Light and Power Company, where he held the position of distribution engineer, until joining Ferranti Electric in August 1956.

C. B. R. Macdonald, M.E.I.C., general manager of John Howard and Company (Africa) Limited, building and civil engineering contractors, Lusaka, Northern Rhodesia, has resigned from this appointment and is at present residing at Hindhead, Surrey, England.

Practising engineering for many years in Canada, South America, the West Indies, Europe, and the Middle East, Mr. Macdonald went to Africa several years ago. Within the last ten years he has been associated with Raymond Concrete Pile Company of Venezuela, and with Humphreys Limited, London, at Gibralter, as resident engineer.

He is a graduate of the Royal Military College, Kingston.

D. E. Doxsee, M.E.I.C., of the M. W. Kellogg Company, construction department, has concluded an assignment at Grande Prairie, Alta., and has been transferred to the firm's American parent company as a special studies engineer. He expects to spend a number of months in the United States.

Mr. Doxsee is a mechanical engineering graduate of the University of British Columbia, class of 1951.

W. K. Clawson, M.E.I.C., of the M. M. Dillon and Company, London, Ont., has been transferred to the Toronto office of the firm.

Mr. Clawson has been employed with the company for a number of years.

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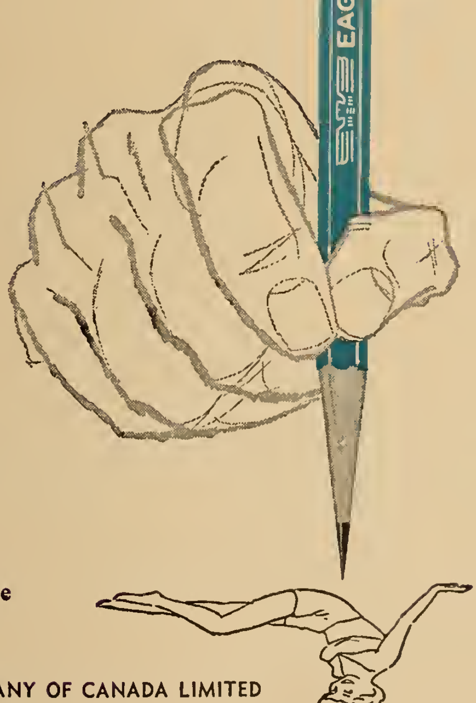

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• PERSONALS

He is a 1940 graduate of the University of Toronto in civil engineering, and earlier in his career was associated with the County of Middlesex, Ont., as county engineer and road superintendent, on his return from service with the R.C.E. in World War II.

A. R. Bonnell, M.E.I.C., district engineer for the New Brunswick Department of Public Works, is the 1956-57 choice of the members of the Northern New Brunswick Branch of the Institute for chairman.

Born at Sussex, N.B., Mr. Bonnell received his engineering training at the University of New Brunswick, from which he graduated in civil engineering in 1935.

After five years experience in highway construction with the Province of New Brunswick, Mr. Bonnell, was engaged for another five-year period in oilfield, mining and defence construction in the West Indies.

On his return to Canada he spent eight years as city engineer at Lancaster, N.B.

W. A. Ker, M.E.I.C., has recently established a consulting engineering practice at Victoria, B.C. Formerly deputy comptroller of Water Rights for the Province of British Columbia, he served with the Water Rights Branch in various capacities for the past ten years, gaining experience in the field of water resource investigation and development. He plans to continue in this field, specializing in water supply and hydraulics. Mr. Ker is a graduate in civil engineering from the University of British Columbia, class of 1945. Earlier in his career he was employed by Northern Construction and J. W. Stewart Limited.

He is a past chairman of the Central B.C. Branch of the Institute.

Stanley, Grimble, Roblin Limited

Three E.I.C. members comprise the firm of Stanley, Grimble and Roblin, consulting engineers, of Edmonton.

A. R. Bonnell, M.E.I.C.

W. A. Ker, M.E.I.C.

Donald R. Stanley, M.E.I.C., formerly of the firm of D. R. Stanley and Associates, consulting engineers, Edmonton is a University of Alberta graduate, class of 1940, in civil engineering. In 1952 he obtained a Doctor of Science degree in sanitary engineering from Harvard University.

Dr. Stanley's experience includes two years spent on the hydro-electric power development of the Calgary Power Company, as supervisor of construction, and three and a half years in the R.C.A.F. as an engineering officer. For four years director of the division of sanitary engineering, with the Department of Public Health for the Province of Alberta he was also a member of the Provincial Board of Health, responsible for the approval of plans and specifications for all waterworks and sewage construction in Alberta. Dr. Stanley also held Rockefeller Foundation and Dominion Government Fellowships for post graduate study at Harvard University, conducting research studies on water filtration. Principal member of the firm of Associated Engineering Services Limited, for two years, he was special consultant to the Dominion Provincial Board, Fraser River Basin, on the pollution of the Fraser River.

Louis G. Grimble, M.E.I.C., holds a Master of Science degree from the University of Illinois, in structural engineering, and has had two years experience on bridge design and construction with the United States Federal Bureau of Roads, and two years as a pilot in the R.C.N.V.R. He spent eight years in the service of the Alberta Department of Highways, resigning in 1954 as chief bridge engineer. Since then he has been employed as a construction engineer with Burns and Dutton Concrete and Construction Company.

He is originally a graduate of the University of Alberta in civil engineering.

Herbert L. Roblin, M.E.I.C., councillor representing the Edmonton Branch of the Institute for the current year was associated with the Canadian National and Canadian Pacific Railways for many years. He was engaged in railway location construction work for ten years, and spent thirty years in railway maintenance and operation. He retired from the duties of division engineer at Edmonton in 1955 to become a member of the firm of Hanley, Grimble, Roblin Limited.

H. L. Roblin, M.E.I.C.

D. R. Stanley, M.E.I.C.

L. G. Grimble, M.E.I.C.

Alkylation unit of the new Petrofina Refinery at Pointaux-Trembles, Quebec.

• PERSONALS

A veteran of two World Wars and a graduate of the University of Toronto he served with the Canadian Expeditionary Force during World War I and received the Military Cross. In the more recent conflict he was in command of the 13th Field Company of the R.C.E. at Regina, Sask., retiring in 1945 with the permanent rank of major.

T. Dumas, M.E.I.C., who was formerly associated with the firm of Lawrason's and Company, London, Ont., has accepted employment with the Department of Agriculture, London, Ont., as a research chemist at the science service laboratory.

R. A. de Villers, M.E.I.C., since 1945, president of Lumber Products Manufacturing and Export Company, Princeville, Que., and secretary and general manager of Paul de Villers and Sons Inc., Princeville, has opened a private practice as a consulting engineer at Montreal.

Mr. de Villers graduated from the Ecole Polytechnique in 1942 in civil engineering. Early in his career gaining experience with Canadian Marconi Company, Montreal, he later joined the Canadian National Railways as an assistant engineer in the Bureau of Research. He remained with the company until 1953, resigning as assistant district engineer at Levis, Que.

Bernard D. Wood, M.E.I.C., has left the staff of the University of Manitoba, department of mechanical engineering, and is now associated with Syracuse University in that department.

Mr. Wood obtained an M.A.Sc. degree from the University of Toronto in 1952.

D. R. Bakewell, M.E.I.C., has accepted the appointment of general manager of C. D. Schultz, a firm of engineers, foresters and consultants, with headquarters in Vancouver and Seattle.

Formerly operations manager with the company, Mr. Bakewell has been responsible for all projects undertaken by it since 1952.

He is a forestry engineering graduate of the University of British Columbia, class of 1946.

Robert M. Rice, M.E.I.C., who formerly held the position of industrial sales representative for Imperial Oil Limited, at Sydney, N.S., has been transferred to Halifax. His new position is that of supervisor of the industrial and commercial sales, for the maritimes.

He is a University of Manitoba graduate, class of 1950, in electrical engineering.

John A. Havers, M.E.I.C., has for a number of months been employed at Honolulu, Hawaii. He is with the firm of Harland Bartholomew and Associates, city planners, civil engineers and landscape architects.

Mr. Havers graduated from the University of Saskatchewan in 1947 with a B.Eng. degree in civil engineering, and then went on to Purdue University, Lafayette, Indiana, where he obtained an M.Sc. degree, specializing in soil mechanics, in 1953.

Karl E. Buchmann, M.E.I.C., for eleven years designer and draughtsman for McIntyre Porcupine Mines Limited, Schumacher, Ont., has accepted an appointment as resident engineer for Kilborn Engineering Limited at the Spanish American Mine, Elliot Lake, Ont.

Through the years working for various mining concerns, Mr. Buchmann has, in more recent times been associated with the Normetal Mining Corporation, Toronto, and with the Buffalo Ankerite Mine, South Porcupine, Ont.

He is a University of Toronto graduate.

Merritt M. Davis, M.E.I.C., has joined the staff of the Department of civil engineering of the University of Toronto, as an assistant professor. He is also assistant-director of the joint highway research program of the University of To-

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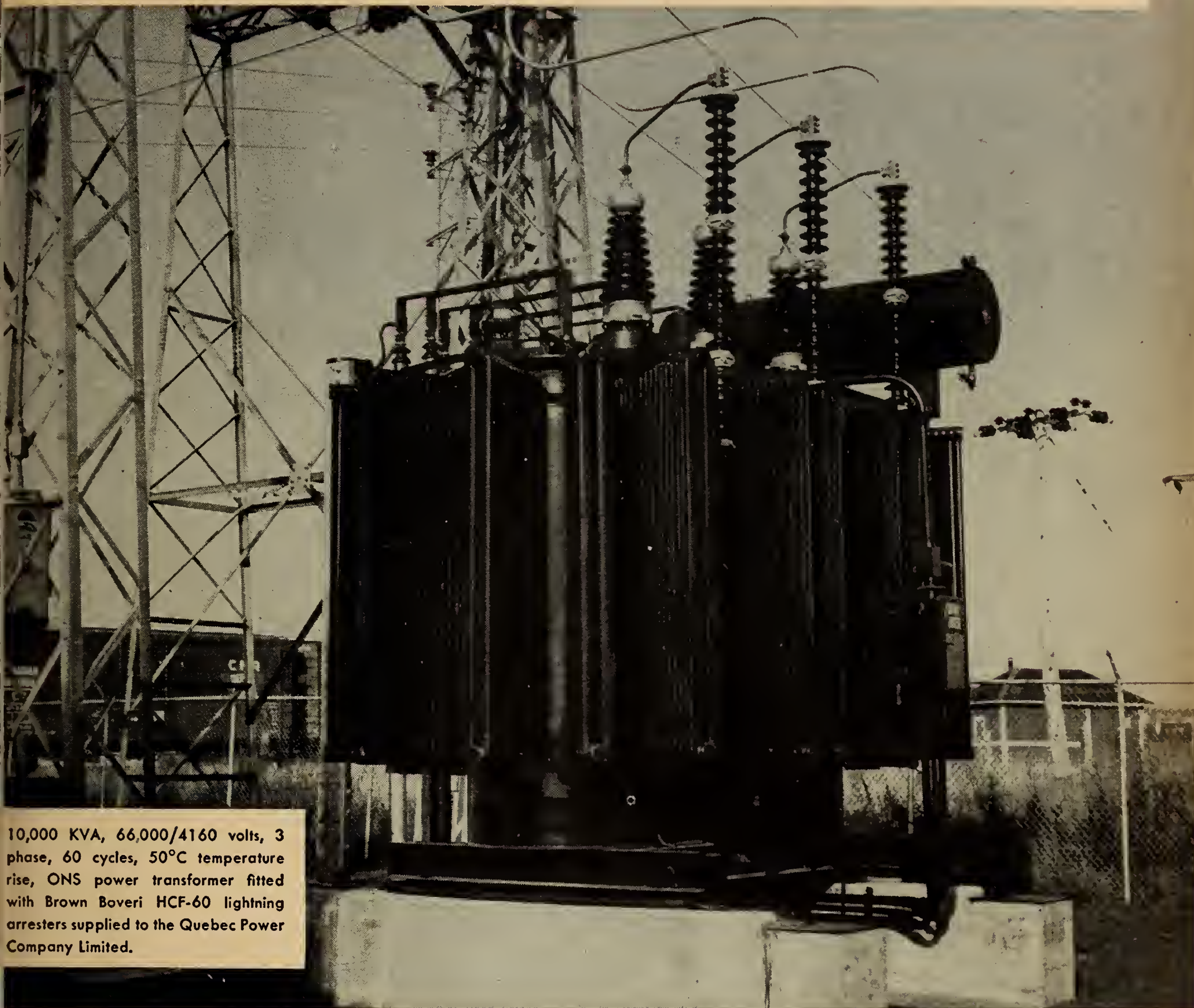

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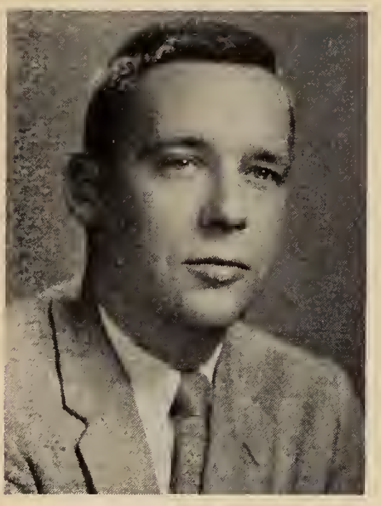
• PERSONALS

ronto and the Ontario Department of Highways.

Prof. Davis obtained his B.Sc. in civil engineering from Queen's University, Kingston, in 1945, and then served with the Canadian Army in Canada and Europe as a lieutenant. In 1947, he joined the Ontario Department of Highways and remained in this work until his recent appointment to the University of Toronto. Granted leave-of-absence by the Department in 1947-48 to undertake post-graduate studies at Purdue University, majoring in highway engineering he obtained the degree of M.Sc. in 1949.



M. M. Davis, M.E.I.C.

D. G. Dawson, JR.E.I.C., is employed with the British Thomson-Houston Company (Canada) Limited, Toronto, following a period of two years spent in Great Britain at the main works of British Thomson-Houston Company, under the provisions of an Athlone Fellowship.

Mr. Dawson received a B.Sc. degree in electrical engineering from the University of Alberta in 1954.

H. S. Ragan, JR.E.I.C., has joined the firm of Stanley, Grimble, Roblin Limited, consulting engineers of Edmonton, as chief design engineer. He will make his headquarters in Edmonton.

A native of Calgary, Mr. Ragan had his early education at Edmonton and obtained a B.Sc. degree in civil engineering from the University of Alberta. Employed by the Department of Highways, of Alberta, bridge branch, from 1950 to 1956, he was engaged in the design and construction of numerous large bridges. During the past three years he was the chief design engineer in that department.

H. S. Ragan, JR.E.I.C.

Paul-Emile Drouin, JR.E.I.C., for a number of years associated with the hydraulic laboratory, Ecole Polytechnique, has joined the staff of Hydro-Quebec, servicing the power development division, hydraulic section.

An Ecole Polytechnique graduate, class of 1947, in civil engineering, he also holds an M.Eng. degree, from McGill University gained in 1952.

L. A. Quinn, JR.E.I.C., has left the sales engineering staff of American-Marsh Pumps (Canada) Limited, Stratford, Ont., to take a position with the Demerara Bauxite Company Limited, Mackenzie, British Guiana, as a mechanical engineer.

A University of Toronto graduate in mechanical engineering, he obtained his degree in 1953.

Earl W. Fee, JR.E.I.C., an Athlone Fellowship winner of 1953, has concluded his studies abroad, and has accepted a position with Atomic Energy of Canada Limited, Deep River, Ont.

Mr. Fee spent the first year of his fellowship with the English Electric Company Limited, at Rugby, Eng., later proceeding to the Atomic Energy Research Establishment at Harwell, Eng., where he studied atomic power plant design.

Mr. Fee received a B.A.Sc. degree from the University of Toronto in 1953.

G. J. MacHutchin, JR.E.I.C., who has elected a director and appointed executive vice-president of Diamond Flooring Limited, specialists in the design and installation of concrete floor finishes. Mr. MacHutchin has been with the firm since his graduation from McGill University as a civil engineer in 1952.

G. J. MacHutchin, JR.E.I.C.

T. H. Legg, JR.E.I.C., a graduate of the University of British Columbia, class of 1953 in engineering physics, has left Montreal and is employed with the Radio Physics Laboratory of the Defence Research Board, at Ottawa.

E. Davis Christian, JR.E.I.C., formerly employed with the New Brunswick Electric Power Commission, Fredericton, N.B., has joined the Federal Department of Trans-Canada Highways, engineering staff. He is presently employed on the Cabot Trail, Cape Breton Highlands National Park, at Cheticamp, N.S.

A B.Sc. graduate in civil engineering from the University of New Brunswick, he obtained his degree in 1954.

G. Lepinay. JR.E.I.C., a Laval University graduate, class of 1953 is presently working with the firm of Michaud and Semard Inc., general contractors, Quebec City, Que.

Mr. Lepinay joined the Department of Public Works, Province of Quebec, on graduation and carried out the duties of assistant district engineer.

Michael E. M. Gibson, JR.E.I.C., a 1954 graduate in civil engineering of the University of Dublin, formerly associated with the firm of Proctor, Redfern and Laughlin, Scarboro, Ont., has recently accepted a position at Niagara Falls, Ont. He is engaged in design engineering with H. G. Acres and Company Limited.

A. D. Scothorn, JR.E.I.C., is employed with the Department of National Defence, Directorate of Works, at Ottawa.

Mr. Scothorn has had previous experience with the firm of Margison, Babcock and Associates, Toronto, and with Canadian Arsenals Limited, Montreal, Que.

He is a 1951 graduate in mechanical engineering from the Nova Scotia Technical College.

Richard N. Outhouse, JR.E.I.C., has returned to this country after spending some time in Great Britain with the educational department of Metropolitan Vickers Electrical Company Limited, Manchester.

He is at present at work as a sales engineer with the firm of Peacock Brothers Limited, Montreal.

Mr. Outhouse is a Nova Scotia Technical College graduate, class of 1953 in mechanical engineering.

J. S. Coopman, JR.E.I.C., has accepted employment with the firm of Joice-Sweanor Electric Limited, at Port Hope, Ont.

A Queen's University graduate of the class of 1954, Mr. Coopman has held

• PERSONALS

professional association with the English Electric Company of Canada Limited and with Mutual Boiler and Machinery Inc., at Toronto, as an electrical inspection engineer.

C. R. Vivian, JR.E.I.C., has transferred from the engineering staff of the Newfoundland Light and Power Company, Limited, at St. John's to the position of superintendent of the company's central division, with headquarters at Grand Falls.

Mr. Vivian has been associated with the Nfld. Light and Power Company on various construction projects since graduation from the Nova Scotia Technical College in 1950.

A. G. MacDonald, JR.E.I.C., has accepted employment with Burns and Company, engineering department at head office, Calgary.

Mr. MacDonald is originally from Eastern Canada, where he graduated from McGill University in 1953 and held several positions in the electrical engineering field.

Before embarking on his present duties, Mr. MacDonald was associated with Wirtanen Electric Company Limited, Edmonton and with K. Siemens, a consulting mechanical engineer, also at Edmonton, as an electrical engineer.

R. D. Hall, JR.E.I.C., utility engineer with the City of Lethbridge, has been re-elected to serve as secretary-treasurer of the Lethbridge Branch of the Institute. This is his sixth term of office. A native of Camrose, Alta, Mr. Hall received his public and high school education in Alberta, and graduated from the University of Alberta with a B.Sc. degree in electrical engineering in 1948. He also spent two years in the Canadian Army.

Following graduation Mr. Hall was employed in the station section of the Hydro Electric Power Commission of Ontario at Toronto and in 1950 transferred to the communications section of the same organization.

In 1951 he accepted employment with the City of Lethbridge and also began his lengthy term of office with the Lethbridge Branch of the Institute.

R. D. Hall, JR.E.I.C.

Guy Pelletier, S.E.I.C., a 1956 graduate of Laval University in chemical engineering is technical assistant to the operating superintendent of plastics, with Monsanto Canada Limited, Montreal.

Robert L. Wright, S.E.I.C., a B.Eng. graduate from McGill University, class of 1956, has accepted employment as a junior engineer with Horton Steel Works Limited, Fort Erie, Ont.

Mr. Wright won the 1956 students prize of the Montreal Branch of the Institute.

R. D. Boyd,, S.E.I.C., a 1956 graduate in civil engineering from McGill University, has accepted a position with Dominion Bridge Company Limited, Montreal.

NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

AMHERST

W. G. MILLER, Jr.E.I.C.,
Secretary-Treasurer

Tour of Shepody Dam

On Sunday, October 28, a party of branch members, their wives, and a few guests visited the Shepody dam, at Albert, N.B.

The Shepody dam is the largest single structure built to date by the Maritime Marshland Rehabilitation Administration under Canada Agriculture. It consists of a rock-fill dam; a by-pass section closed by rock fill and timber core; and gate structures. The overall length is approximately 1600 feet, with a maximum vertical height of about 55 feet. The water flow is controlled by two steel vertical lift gates 20 feet wide and 16 feet high, and water diverted through the by-pass on March 5, and the by-pass was closed on March 22, 1956. A very important factor in the successful closure was the detailed study on a scale model in the hydraulics laboratory in Amherst.

Project Described. J. D. Conlon, chief engineer, M.M.R.A., and C. D. Carter, resident engineer, explained the project to the party. Mr. Carter also briefly outlined the work necessary for the final completion, including the rock facing of heavy adjoining dykes, and other protective works.

After visiting the dam, the party drove around the district to see the 5,576 acres of land now protected from the tide by the new works. The trip was concluded by dinner in Moncton.

BELLEVILLE

E. T. HILBIG, Jr.E.I.C.,
Secretary-treasurer

What is a Silicone?

The Belleville Branch of the E.I.C. held its first meeting for the 1956-57 season on November 12, 1956.

The guest speaker was H. D. Hamilton who is manager of electrical and silastic sales of Dow Corning Silicones Ltd. at Toronto. He delivered a very comprehensive talk on silicones, supplementing his remarks with slides and a film entitled "What's a Silicone".

The speaker outlined the history of the formation of Dow Corning Silicones Ltd. The need for an electrical insulating material having good stability at fairly high temperatures led the Corning Glass Works to turn to the Dow Chemical Company for assistance. A subsidiary company consisting of members from both parent companies was organized in 1942. One year later the first product was produced.

Three Silicone Groups. Silicone products, in general, come under one of three groups, namely fluids or oils, silastics, and resins.

Silicone oils having either extremely high or extremely low viscosities can now be produced. On the other hand, oils having a stable viscosity over a wide temperature range are also manufactured. They are used as a damping fluid in various kinds of meters and as a low temperature lubricant. As a lubricant, the non-sludging property of silicone oil, and the fact that the chemical composition is such that oxidation is practically inhibited, are of particular importance. The use of these oils as a protective coating for glass is rather interesting. Such a coating leaves the surface of the glass so well lubricated that an inadverdent contact or blow, is translated into sliding action thereby avoiding breakage. Silicone greases, which are basically silicone oils with fillers added, naturally display most of the same desirable properties.

Silastics, the rubbery type of materials, which because of their non-carbonizing property and their high thermal conductivity, are used extensively as the insulating medium for power and control cables on ships. On account of the excellent thermal properties displayed, the addition of 5 - 10% of silastic "rubber" to automotive tires increases their life considerably.

The third group of silicones namely, resins, are used extensively for insulating the windings of motors and generators because of the desirability of using a fire-resistant material and particularly because of the inherent thermal properties. A motor, thus insulated, can have its horse power rated upwards by as much as 50%.

The speaker was thanked by Mr. Sillitoe.

CORNWALL

V. A. HARRISON, M.E.I.C.,
Publicity Chairman

Commonwealth Study Conference

The second fall meeting of the Cornwall Branch was held October 3 at the Cornwall Golf and Country Club. R. D. Archibald, secretary of Dominion Textiles Ltd. gave a compehensive outline of the Duke of Edinburgh's Study Conference held in England last July.

Mr. Archibald, a Canadian representative, described it as an enriching and broadening experience and one of the best organized conferences he had ever attended.

Also present at the meeting was Sir John Hanbury-Williams, chairman of the Board of Courtaulds Limited, who was honorary treasurer of the council set up by the Duke to organize the conference. Sir John described how the idea of the conference had grown out of the Duke's experiences in visiting hundreds of industrial concerns throughout the Commonwealth.

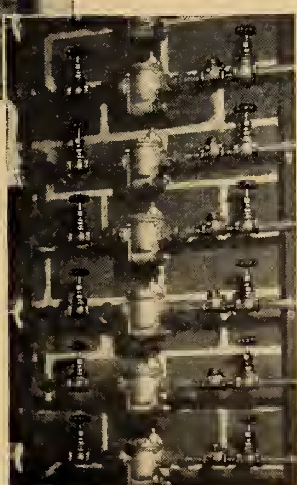
Differences Noted. The Duke had been struck by the difference in attitudes he found in the various plants he visited, and by the differences in the relationships between industries and communities. After discussion, a conference of representatives from all parts of the Commonwealth and Empire was decided upon, "The Duke of Edinburgh's Study Conference on Human Problems of Industrial Communities within the Commonwealth and Empire".

"The whole program was focussed on the individual living in an industrial community," Mr. Archibald said. A second aim of the conference was to give some help to the newer industrial coun-

On duty at the new Montreal General Hospital

JENKINS VALVES

TOP:
An installation of Jenkins Bronze Gate Valves on the fuel oil pump manifold in the power house.



RIGHT:
Jenkins Bronze Gate and Swing Check Valves in the fan room. This installation is part of the air-conditioning for the hospital's operating theatre on the eighth floor, where temperature varying from 72 to 74 degrees must be constantly maintained.

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McDougall and Friedman

ARCHITECTS:
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GENERAL CONTRACTOR:
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Nurses' Home — John Colford Contracting Co. Ltd.

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• BRANCH NEWS

tries like Pakistan, which might be able to avoid some of the mistakes made in the older industrial communities.

At the end of the three-week period of lectures, study groups and tours to factories in many parts of England, Mr. Archibald said one of his chief impressions was that "the factories where the employees seem to be the happiest, where they put the most into and get the most out of their jobs, are those where they know what is going on . . . These are the plants where the line managers make people the principal part of their jobs."

Another impression, said Mr. Archibald, was that in the Western world's industrial democracy, it was absolutely essential that equipment be kept up to date.

The speaker also had praise for the hospitality of all the people he had met on the conference, and remarked on the fine reception they received in all the plants they visited. They were given free access, he said, and permitted to move about the plants asking any questions they wanted.

Broad Representation. It was also a broadening experience, he said. For detailed study the conference of 280 persons was broken down into 20 groups of 14 persons, each with its own chairman. These were carefully "mixed". His own group, said Mr. Archibald, had included a director of a Pakistan tobacco plant, a trade union organizer from Yorkshire, a lathe operator from Ireland, a coloured plantation manager from Nigeria and a civil servant from Singapore who was also a union leader.

The Duke of Edinburgh, who had presided for most of the plenary sessions that opened the conference impressed Mr. Archibald as being highly alert, with a good sense of humour and deep sincerity — "All the qualities you would look for in a leader."

Speakers were top industrialists who usually gave hour-long papers to the whole group, which would then break up into 14-man sessions to consider them. About 10 days of the conference were spent in visiting industrial sites in various parts of the country.

CALGARY

R. G. PRICE, M.E.I.C.,
Branch News Editor

Brian McNally is Speaker

The Calgary Branch of the E.I.C. held an evening meeting in the Palliser Hotel on Thursday, November 8. Brian McNally described the new N.W. Nitro-Chemical Plant at Medicine Hat, Alberta, in which he is employeed as plant engineer. This new $21.5 million fertilizer manufacturing plant was just getting into production and had produced its first sack of fertilizer the day of Mr. McNally's address.

Imperial Oil Research Centre

Personnel of the new million dollar Imperial Oil Research Centre in S. E. Calgary were hosts to the Calgary Branch on the evening of November 22 and about 150 members took the opportunity to examine the Centre. Jim Young of Imperial, who is in charge of the Centre and his very obliging assistants served refreshments at the conclusion of the tour.

FREDERICTON

G. R. W. BLISS, JR.E.I.C.,
Chairman,
Public Relations Committee

O. I. LOGUE, M.E.I.C.,
Secretary-treasurer

Engineering Education

On Monday evening, November 5, the Fredericton Branch held a very enjoyable dinner meeting chaired by Ira Beattie, president of the branch. It was highlighted by the presentation of a paper on Engineering Education by Prof. James O. Dineen, head of the electrical engineering department of the University of New Brunswick.

Prof. Dineen was introduced by R. E. Tweeddale, assistant chief engineer, of the N.B.E.P.C. Mr. Tweeddale mentioned that every engineer should take an interest in the training of future engineers and should also keep abreast of modern developments in the scientific world.

Prof. Dineen began his talk by saying that there were two types of knowledge, social knowledge and material knowledge. He stated that social knowledge has been rather gradual through the years, and that "man has gradually evolved from the barbaric tribes of early ages to the relatively civilized society of the present day."

The remainder of Prof. Dineen's paper dealt with material or scientific knowledge from the time the Egyptians first developed and applied geometry, up to the present day.

In his history of the development of engineering, Prof. Dineen mentioned the contributions of such men as Galileo and Leonardo di Vinci in the middle ages. In the 19th century, he said, the fundamental discoveries of men like Volta, Oerstead, Ampere, Gauss and Faraday laid the foundation for practical applications of Morse, Maxwell, Edison, Bell, Stanley, Westinghouse, Flemming, Marconi and many others. Because of the feverish race to convert these fundamental discoveries into commercial enterprises, engineering schools arose. U.N.B., one of the first engineering schools in the country began giving instruction in engineering in 1854.

Prof. Dineen then traced the development of the engineering profession from 1900. He then outlined some of the demands and problems that have to be met by the engineers of today. The civil engineer has five great problems facing him: traffic congestion, municipal rehabilitation, adequate water resources, industrial pollution, and highway reconstruction and safety. The mechanical engineer deals with the production of power, and the conception, design and manufacture of devices. The commodity of the electrical engineer, electricity, cannot be observed as can the works of the civil engineer and the machine tools and products of the mechanical engineer. "Its study requires emphasis on imagination, and understanding of classical and modern physics and a heavy reliance on mathematical analysis," he stated.

Educational Trends. Prof. Dineen then outlined some trends in under-graduate curricula and outlined the graduate programs of the universities. He said that we should provide the graduate with sound training in fundamentals and develop his ability for creative thinking, and leave the more specialized training to graduate schools. He also mentioned that many companies give the new graduate a one or two year training course. This gives the graduate an opportunity to become familiar with all phases of the company's work. In the United States many companies make provision for selected employees to attend advanced courses at local universities.

In conclusion Prof. Dineen stated that there comes a time in each career when formal education ceases. Then it is up to the individual to keep abreast of the developments in his own field of endeavour and to cultivate a habit of self education.

KINGSTON

D. I. OUROM, JR.E.I.C.,
Secretary-treasurer

Knob Lake — Sept Iles

Our second meeting of the 1956-57 season, attended by some 50 members, students and guests, was held at R.M.C. on the 20th of November.

The speaker for the evening was Mr. J. A. Little, general manager of the Quebec North Shore and Labrador Railway at Sept Iles, Quebec. Mr. Little discussed the historical background of the Knob Lake — Sept Iles area and then described in detail the building of the railroad linking the ore body at Knob Lake

• BRANCH NEWS

with the docks at Sept Iles. His talk was supplemented by the film 'Iron Ore by '54' which pointed up the highlights of this extensive project.

KITCHENER

J. L. FAIR, M.E.I.C.,
Branch News Editor

Water Resources

A. M. Snider of Kitchener, chairman of the Ontario Water Resources Commission, addressed the branch at the November meeting. The commission was established this year by provincial legislation, with guiding principles similar to those of the Hydro Electric Power Commission.

The functions of the commission are:

(a) To develop and make available supplies of water.

(b) To construct and operate systems for the supply and purification and distribution of water and for the disposal of sewage.

c) To enter into agreements with respect to the supply of water or the disposal of sewage.

(d) To conduct research programs and to prepare statistics for its purpose.

(e) To perform such other functions or discharge such other duties as may be assigned to it from time to time by the Lieutenant Governor in Council.

Mr. Snider said, "This act is a departure from practices followed here in the past, and is without parallel elsewhere in Canada or United States. In general the Commission is authorized to build, finance and operate water supply and sewage disposal projects. This is a comprehensive program designed to ensure water resources that will be adequate for the needs of the development of this Province."

Advantages Outlined. There are advantages to be derived from the Commission's operations:

1) Money is borrowed by Provincial Commission at rates usually lower than municipalities, and at longer term than for municipal borrowing —thirty year basis usually. There is no increase in municipal debt — money is borrowed by the Commission.

(2) Best engineering assistance available ensures excellent modern design. Operation of plant is under modern scientific control at all times with latest improvements introduced regularly.

Referring to importance of regional planning, Mr. Snider said: "An agreement to supply works is not to be restricted to single municipalities. Water supply and waste disposal must be considered as area or regional problems rather than be restricted to municipal boundaries. It is not always easy for communities to agree among themselves on joint programs, regardless of the advantages of such compacts. The Water Resources Commission is prepared to consider services to all municipalties in an area whether there be a water works pumping plant or a sewage treatment plant. The allocation of costs among the municipalities or areas served can be made by the Commission without undue difficulty."

Some idea of the magnitude of the task facing Ontario in the next twenty years was given by the estimate of $2.4 billion for water and sewage works projects to keep pace with requirement of homes and industry.

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Plant Tours

For the October meeting, the branch members and friends inspected the plants of Sheldons Engineering Ltd., and Joy Manufacturing Company (Canada) Ltd.

In the Sheldons plant the visitors inspected a wide range of air moving equipment, as well as the installations for testing, dynamic balancing, and some new manufacturing techniques.

At the Joy plant the role of air in engineering was seen in another way—the manufacture of compressors and compressed air tools, particularly for the mining industry. At the close of the tour, refreshments were served in the plant cafeteria.

The Kitchener branch records its appreciation to the managements of these companies for two most interesting tours.

NIPISSING AND UPPER OTTAWA

J. W. MILLAR, M.E.I.C.,
Branch News Editor

Dinner Meeting

The Nipissing and Upper Ottawa Branch held its November dinner meeting in the Dragon Room of the Golden Dragon Restaurant in Ferris, Ont., on November 22. Chairman T. C. Macnabb presided at the well attended meeting.

After dinner, Dick Booey introduced the speaker Douglas Walkington, Montreal, of the chemicals division of Canadian Industries Limited and who at the present is particularly interested in market research and public relations.

Mr. Walkington started his talk by pointing out what chemistry had done for industry and how chemistry had provided the material and the engineer had put it to use. He cited the heavy industries such as pulp and paper, mining and construction where chemistry played a large part in providing materials to be used in the processes for producing wood pulp and paper and refining ores. Agriculture uses a great many chemicals and these included insecticides and Mr. Walkington pointed out that insects soon become immune to insecticides and new ones have to be developed.

Use of Plastics. He then dealt with plastics, and saying there were twenty major plastics, each with many variations. In order to properly use plastics, industry must understand that each had special properties and the proper plastic must be used to obtain the best results. Mr. Walkington illustrated his talk with a variety of articles made from plastics, including polythene rope, plastic water pipe, toys, plumbing fixtures, etc. He also had an assortment of textiles and enlarged on the contribution of chemistry to the textile industry in the development of rayon, nylon, dacron, orlon and terylene all of which have their special uses and are generally used in combination with wool and cotton.

A discussion period followed, and Mr. Walkington ably answered many questions put to him by the engineers. The speaker was thanked by J. W. Millar.

NORTHERN NEW BRUNSWICK

BERNARD BEATON, JR.E.I.C.,
Branch News Editor

Power for New Brunswick

A general meeting of the Northern New Brunswick Branch of the Engineering Institute of Canada was held at the Miramichi Golf and Country Club at 8:00 p.m., November 3, 1956. There were twenty-two engineers and guests present.

The meeting was called to order by the chairman, A. R. Bonnell. B. Beaton was appointed executive member for Restigouche to fill the vacancy left by A. R. Bonnell when he moved up to the chairmanship of the Branch.

The chairman introduced the speaker of the evening, Reginald Tweeddale, assistant chief engineer of the New Brunswick Electric Power Commission. Mr. Tweeddale extended greetings from the Fredericton Branch of the Institute.

"Power for New Brunswick" is a topic, he said which has not been fully appreciated by the people of this province. Consequently, the commission, being a public utility, has instituted a program of education on this subject.

Mr. Tweeddale expanded his subject on the following topics with the aid of a map of the N.B. Power System, and a physical cardex-graph system of the power growth of the Province:

1. The existing generating stations.
2. The new 69- and 138-kv. overlay transmission systems.
3. The six rural distribution districts of the Province.
4. Future buildup of system to meet average 10% increase per annum.
5. The installation of larger generators and tie-ins with heavy industry.
6. Two new thermal plants for the province.
7. Power will be the key to development of the mining industry in the north of the province and about Woodstock.
8. The potential of the St. John River hydro developments; example at hand is the 135,000 hp. development at Beechwood.
9. The integration of hydro with thermal with our eyes on new sources of power, such as d-c, high voltage transmission from Hamilton Fall, atomic power plants and tidal power.

A colour film was shown on Beechwood construction to date with explanatory comments by Mr. Tweeddale.

OTTAWA

STEWART G. FROST, JR.E.I.C.,
Branch News Editor

NATO is Discussed

NATO must be maintained as a tangible deterrent to Russian aggression and Canadians must set an example in supporting its principles and armed forces. This was the thought expressed by Donald C. MacCallum, president of Racey-MacCallum and Associates, Montreal, who spoke at a special Junior Section luncheon meeting of the Ottawa Branch on November 15.

Mr. MacCallum, recently returned from a tour of NATO establishments in Europe, warned against any relaxation of vigilance in maintaining a state of preparedness against a Russian attack. The New Look, assumed by Russia since the relegation of Stalin, has prompted some to suggest the abolition of the atomic bomb and the withdrawal of armed forces from Europe. Under no circumstances, emphasized Mr. MacCallum, must we be led astray by such fuzzy thinking, for we are probably faced with a more dangerous Russia than ever before.

NATO's Organization. As one of a group of members of the Canadian Industrial Preparedness Association, Mr. MacCallum was privileged to meet and confer with those responsible for keeping NATO an efficient and effective body. Lord Ismay, vice-chairman and general secretary of NATO, together with his staff, thoroughly briefed the group on the philosophy, set-up, and functioning of the organization. Similarly General Gruenther outlined the extensiveness of the military force under his command at SHAPE. Mr. MacCallum was particularly impressed by the state of training and morale of the Canadian forces. These forces consist of an air division under Air Vice-Marshal Brandy Godwin and an army brigade under Brigadier Rober Rowley.

Having been fortunate enough to gain this first hand information Mr. MacCallum welcomed this opportunity to pass on the impressions he had formed. NATO, he said, has been highly successful in confining Russian operations and is absolutely essential if the status quo is to be maintained; it must receive the full support of all Canadians.

Herb Gladish, chairman of the Junior Section, presided at the luncheon and introduced the speaker. At the head table with Mr. MacCallum were Professor R. H. Galbraith and student representative John Belanger of Ottawa University, Professor E. E. Goldsmith and student representative Richard Baird of Carleton College, and Brig. J. P. Carriere, vice-chairman of the Ottawa Branch. The speaker was thanked by Stewart G. Frost.

Aklavik

"The New Aklavik—Search for the Site" was the subject of a paper presented by R. F. Legget and J. A. Pihlainen to the Ottawa Branch on October 18. Mr. Legget is director of the Division of Building Research of the National Research Council and Mr. Pihlainen is head of the Permafrost Section of that Division. Together with C. W. Merrill, now district administrator for the Department of Northern Affairs and National Resources at Fort Smith, they had participated actively in the search for the new site for Aklavik and had pooled their experiences in preparing the paper.

The growth and development of Aklavik and the reasons for moving it were first discussed by Mr. Legget. Originating as a fur trading post, as recently as 1918, Aklavik gradually grew with the establishment there of an Anglican Mission, an R.C.M.P. station, a Hudson Bay post, a Roman Catholic Mission, and a signal station of the Royal Canadian Corps of Signals. Today Aklavik boasts a permanent population of about 400.

Its location north of the 68th parallel and on the delta of the Mackenzie River causes Aklavik to be of importance as an administrative centre for the Canadian Northwest. It is not surprising, therefore, that the Government of Canada should take an active interest in the growth and development of the site.

Paradoxically, those factors which make the town important are also responsible for hindering its development. The organic silt of the delta and the arctic climate have combined to make soil conditions impossible for permanent buildings. The "permafrost" at Aklavik has been shown to contain 60 per cent ice. Other features such as poor drainage and lack of a good site for an air strip combined to make it necessary to find a new site.

Criteria for New Site. The new Aklavik would have to be acceptable from the commercial and social point of view, it should be close to navigation, it should have a first class airfield and it should have water and sewage. These and many other essential factors provided a guide for those who conducted the survey.

Mr. Pihlainen reported that preparations for the survey were started as early as January 1954 and were coordinated by Mr. Merrill. A preliminary appraisal of the delta area was made using air photographs. Land form patterns were established stereoscopically and identified by soil sampling in strategic locations. Twelve possible townsites were located in this way.

To examine these sites in the field extensive use was made of the helicopter. From the air it was possible to reject eight of the sites as unsuitable. Using special light weight equipment, soil sampling was carried on at the other sites. Much difficulty was experienced in judging the proper amount of wash water, too much water would melt and wash away the ore while too little would freeze the core barrel. Samples were tested and coloured photographs of split representative samples were made for future reference. After the spring break up further sampling was carried out at two of the most promising sites. One site known as "East Three" located about 80 miles by water but only 35 by air from the old town was finally chosen.

The speakers were introduced by the Branch chairman, Colonel E. B. Pennock and thanked by the vice-chairman, Brigadier J. P. Carrier. Guests at this dinner meeting were G. W. Rowley, secretary of the Advisory Committee on Northern Development and F. I. G. Cunningham, Director of Northern Administration and Land Branch of the Department of Northern Affairs and National Resources.

Junior Section Active

On October 25, the Junior Section of the Ottawa Branch commenced its activities this season with a visit to the plant of Computing Devices of Canada at Bell's Corner near Ottawa. Jim Boucher, an executive member of the Junior Section, had invited the juniors and students in the Ottawa area to inspect the new plant.

About 50 juniors and 15 students took part in the outing. Dave Knudson, public relations officer of Computing Devices of Canada was in charge of the plant tour. He, together with other members of his staff guided small groups through the various phases of activity and explained in detail the operation of much that was being done.

Computors Demonstrated. In the data processing the room the groups were given a demonstration on the operation of a digital computor and had the fundamentals of an analog computor explained to them. The wonders of the transistor were demonstrated and other electronic equipment was displayed.

Impressed with the marvels of the electronic age groups returned to the cafeteria where they were treated to coffee and doughnuts. Mr. Gladish, chairman of the Junior Section took this occasion to announce the program of the Junior Section for the coming season and to extend a special welcome to the students of Carleton and Ottawa University to all functions. Mr. Frost thanked Mr. Boucher and Mr. Knudson for a most interesting evening and for their generous hospitality.

Visit to Seaway

The St. Lawrence Seaway and Power Project was visited for a second time on October 27 by four bus loads of members and friends of the Ottawa ranch. This cavalcade left Ottawa at 9:30 a.m. and arrived at Cornwall for luncheon at the Cornwallis Hotel. The group was met there by Charles McIntosh of the Ontario Hydro and was guided by him through the various phases of the work going on between Cornwall and Iroquois.

Power House. Construction work on the power house being built between the Canadian mainland and Barnhart Island was observed from the top of the downstream cellular cofferdam. Next the group proceeded to the arched dam being built at the foot of the Gallop Rapids and to the Eisenhower Lock. The relationship of these structures one to another and the schedule for placing them in operation was clearly explained by Mr. McIntosh.

Control Dam and Townsite. The group then proceeded to Iroquois to view the new control dam being built there and to inspect the new townsite. At the time of this visit the gates of the control dam were near completion and preparations were being made to start work on the second half of the dam. At the new Iroquois townsite the group were taken

Shown below are . . . some of the gentlemen who sat at the head table, on the occasion of the November 15 luncheon meeting of the Ottawa Branch, addressed by D. C. MacCallum, president of Racey-MacCallum and Associates Limited, Montreal. They are, left to right: Prof. E. E. Goldsmith, Carleton College; Prof. R. H. Galbraith, Ottawa University; Herb Gladish, chairman of the Ottawa Junior section; D. C. MacCallum, and Brigadier Carriere, vice-chairman of the Ottawa Branch.

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through the streets of the relocated community and were impressed with the condition of the old houses which had been moved from their old location along the riverfront to this new development.

Before leaving Mr. McIntosh for the return journey home, Mr. Brown, proceedings committee chairman, expressed to him the sincere thanks of the group for his fine explanation and guidance.

TORONTO

EIC-ASCE-ICE Joint Area Committee

B. HARDCASTLE, M.E.I.C.,
Secretary

ACI Building Code

A meeting of the Joint Area Committee was held on October 18, 1956 in Toronto, at which there were approximately eighty members present. H. Fealdman introduced the speaker, Professor Frank Kerekes, dean of faculty, Michigan College of Mining and Technology, and president of the American Concrete Institute.

Professor Kerekes reviewed briefly the organization of the Committee for Revision of the Building Code of the American Concrete Institute, of which he was chairman, and elaborated on the functions of each subcommittee.

The basic approach to structural design developed by this committee dealt with the use of load factors applied to structural analysis based on ultimate strength.

The speaker outlined the difficulties facing the Committee in revising the Building Code of the ACI, dealing in detail with individual problems. He stressed the necessity of treating any code with discretion, and using it in conjunction with fundamental design principles.

Professor Kerekes' address was interspersed with examples taken from his own wide experience.

The wide interest in the paper was evidenced by the stimulating discussion and question period which followed.

B. Hardcastle proposed a vote of thanks to the speaker.

VANCOUVER ISLAND

W. G. McINTOSH, M.E.I.C.,
Branch News Editor

Road Design

The Vancouver Island Branch opened its fall season on October 3 with a joint dinner meeting held in conjunction with the Victoria Branches of the B.C. Association of Professional Engineers and the C.I.M.M. The guest speaker was W. A. Johnson, engineer of soils and foundations, Highway Research Board, Washington, D.C., who spoke on "A Practical Approach to the Design of a Road Section". Mr. Johnson discussed a number of highway research projects at present being undertaken in the United States.

Agassiz Bridge

A second joint meeting was held on October 19, at which Gerald Koster, resident engineer, Bridge Department, Province of B.C., gave an illustrated paper on the new Agassiz-Rosedale Bridge.

Reception for National Officers

On November 10, the Branch held a dinner meeting in connection with the annual visit of the president and the general secretary, to which the ladies were invited. Unfortunately, President V. A. McKillop was unable to be present. In his place, Dean Hardy of the University of Alberta attended and presented a short address. Dr. Wright then gave us an informal account of the present state of Institute affairs. After the dinner, music was provided for dancing.

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VANCOUVER

A. D. CRONK, M.E.I.C.
Secretary-treasurer

Structural Section

Second Meeting

The second regular monthly meeting of the structural section was held on Tuesday, October 16, 1956, in the Willingdon Cafe and was attended by thirty members.

The chairman, Peter Jones, introduced the report of the Douglas Committee on prestressed concrete criteria. These criteria were distributed to those present, who were asked to comment or send comments in before the end of that week. These criteria were then to be submitted to the Consulting Engineers Division of the Association of Professional Engineers for action. Mr. Faliszewski spoke briefly on the work of the committee.

Officers.

Following dinner, the election of officers took place, those elected being: chairman, Dr. Roy Hooley, vice-chairman, Gordon Ellis, secretary-treasurer, Steve Faliszewski.

Mr. Robert Wannop introduced the main speaker, Len Narod, who gave a very interesting talk on the design of the La Conner bridge, a fixed arch steel bridge for which he was the designer. A number of interesting design problems were clearly illustrated, and their solutions outlined. His talk provoked a lively question period. Frank Leighton thanked the speaker.

WINNIPEG

C. S. LANDON, M.E.I.C.,
Secretary Treasurer

Electrical Section

Visit to Cable Plant

Sixty members of the electrical section visited the newly opened Winnipeg plant of the Canada Wire & Cable Company and its subsidiary company Telecables & Wires Limited. The combined plant occupies an area of some 92,000 square feet and incorporates the most modern wire and cable manufacturing machinery. The plant is located on 14 acres of ground in suburban Fort Garry.

Space does not allow a complete technical description but production includes the manufacture of telephone and other communication cables; solid bare copper wire, solid aluminum wire, stranded aluminum wire, A.C.S.R., polyethylene covered line wire, flame seal, N.M.W.10 and triplex. Complete testing facilities are provided.

Thanks are due to the company for an interesting and informative visit.

The Electrical Section held its annual dinner dance at the Marlborough Hotel on Friday evening, November 16. Approximately 210 members, their ladies and other guests attended.

The guest speaker, Miss Mildred McMurray of the Provincial Health and Welfare Department delivered an entertaining and at times thought provoking address entitled "Leaves from a Lawyer's Diary". Miss McMurray's experiences in private law practice and her present concern with family welfare provided some interesting reminiscences.

The Electrical Section dance is an established and popular event in the E.I.C. social calendar. This year we were again fortunate in having our general secretary, Dr. L. Austin Wright with us. Unfortunately the President Mr. V. A. McKillop, who had hoped to attend, was unable to do so because of a business emergency.

News of Other Societies

International Aeronautical Meeting

Toronto was the location chosen for the 1956 fall meeting of the Canadian Aeronautical Institute and the Institute of the Aeronautical Sciences, of U.S.A., held on Monday and Tuesday, November 26-27. Despite the blizzard conditions which prevailed over the weekend, the total registration of around 450 was a tribute to the vitality and spirit of this young Canadian institution.

The Program

The technical program consisted of the W. Rupert Turnbull Lecture, together with twelve papers in four groups under the general headings of Test Flying, Quality Control, Electronics, and Missiles. The titles of these papers, and their authors, were as follows:

1. *The Canadian Test Flying Scene*—Donald H. Rogers, Chief Test Pilot, Avro Aircraft Limited.
2. *Flight Testing of High-Speed Aircraft* — Richard Johnson, Chief Engineering Test Pilot, Convair, San Diego, A Division of General Dynamics Corporation.
3. *RCAF Test and Development* — S/L Owen B. Philp, RCAF. Formerly Chief Test Pilot, Central Experimental and Proving Establishment.
4. *Quality Control Policy in the Royal Canadian Air Force* — G/C Robert McMillan, Chief of Quality Control, RCAF.
5. *Applications of Ultrasonics in Aircraft* — Charles P. Albertson, Supervisor of Sonic Testing; Philip Melara, Supervisor, Quality Control Laboratory, Grumman Aircraft Engineering Corporation.
6. *Control of Deviating Material* — Harold G. Dickie, Supervisor, Quality Review, Canadian Pratt and Whitney Aircraft Company, Limited
7. *Operational Use of TACAN* — Murray Block, Air Traffic Control Specialist, Federal Telephone and Radio Co., 'Div. of International Telephone. and Telegraph Corp.
8. *A Survey of the Advantages of Transistors in Air-Borne Electronic Equipment* — Earl F. Johnson, Head, Semiconductor Engineering Dept., Computing Devices of Canada, Limited.
9. *Airport and Airways Surveillance Radar for Canadian Air Traffic Control* — Bruce McCaffrey, Project Engineer, Radar Dept., Raytheon Manufacturing Company.
10. *Guidance and Control of Missiles* —A. G. Carlton, TRITON Division Supervisor, Applied Physics Laboratory, The Johns Hopkins University.
11. *The Technology of Guided Missiles and Its Effect on Industry* — R. D. Richmond, Chief Development Engineer; J. F. Perrier, Missiles Systems Engineer, Canadair, Limited.
12. *A Method for Evaluating Jet-Propulsion-System Components in Terms of Missile Performance* — R. J. Weber, Roger Luidens, Aeronautical Research Scientists, Lewis Flight Propulsion Laboratory, NACA.

Guided Missile

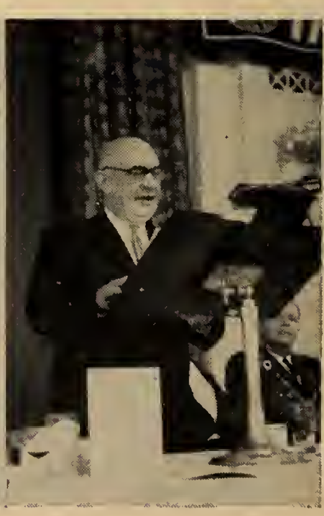
The W. Rupert Turnbull Lecture, presented on Monday afternoon before the whole convention, was given by Simon Ramo, executive vice-president of the Ramo-Wooldridge Corporation of the United States. Mr. Ramo, who has had a distinguished career in aeronautical development, spoke on the subject of "The Guided Missile as a Systems Engineering Problem".

He explained first that his lecture was really on two topics, guided missiles and systems engineering, and it was his endeavour to tie the two together. The lecturer then went on to deal with systems engineering in rather general terms, after which he added some specific examples—in particular the guided missile —and then concluded with ways of how we can improve our knowledge and use of these special engineering techniques.

One interesting aspect of the application of systems engineering, developed by Mr. Ramo in his lecture, was what he called the "arrangement making problem". By this he meant that in some cases the technical problem involved could be solved easier than the problems arising from the introduction of the proposed system itself. The alternate approaches must therefore be carefully examined, he stressed.

The speaker merited congratulations on presenting a most complicated sub-

At the CAI-IAS dinner meeting November 27, l. to r.: T. E. Stephenson, president of the Canadian association, Dr. E. R. Sharp, president of Institute of the Aeronautical Sciences, and C. C. Furnas of the United States, the speaker for this meeting.



ject in clear and understandable language.

At dinner, also on the first day, places were laid for over 600 delegates and guests. The evening program was under the chairmanship of the C.A.I. president, T. E. Stephenson, who called first upon Dr. E. R. Sharp, president of the I.A.S., who is director of the Lewis Flight Propulsion Laboratory. Dr. Sharp brought to the meeting the greetings and good wishes of the society he represents from south of the border.

International Cooperation

Then followed the principal speaker, Clifford C. Furnas, assistant secretary of defense for research and development, U.S.A.

In his beautifully modulated voice Mr. Furnas, author of "The Next 100 Years", opened his talk with a review of what he feels is one of best examples of post war Western integration. He illustrated, with very apt anecdotes and incidents, the fine co-operation that has existed and continues to function between the aeronautical men of the United States, Canada, and Great Britain.

The speaker then pointed up the gravity of the present situation facing mankind. He felt that the problem is twofold: man against nature, and man against man, which is after all an age-old concept of existence. He then expressed the view that Canada and the U.S.A. are engaged on an unprecedented effort of tackling both sides of the task at the same time. In other words, to have both "guns *and* butter". Research and development are going on, both civil and military, on a scale which is bringing about the most rewarding technological advances.

Mr. Furnas could also see that, as we go on into the future, Canada and the United States will have many other new problems in common — problems dealing with our natural resources, and the use of them. We will be faced with building an industrial structure necessary to support the expected vast world population increase of the next several generations. He could see our engineers and scientists turning to sea water, atomic energy, and solar energy for the answers.

Mr. Furnas also reminded the audience of the growing need to pass on the benefits of our advances to the "have-nots" of the rest of the world. He concluded with the warning that this is a critical generation in human history, with a special responsibility.

Tuesday, the second day, was taken up with three more sessions of technical papers, and the meeting then ended. The *Journal* salutes the council, staff, and all those concerned in the C.A.I., for their energy and initiative in adding another successful meeting to their institute's young but impressive record.

International Scientific Radio Union

Letter from Canadian secretary

The twelfth general assembly of the International Scientific Radio Union (known as URSI) will be held at Boulder, Colorado, August 22 to September 5, 1957, by invitation of the U.S.A. National Committee of URSI and the National Academy of Sciences.

Participation in the Assembly, including attendance at technical sessions and special features, is limited to representatives officially designated by the National Committees of the member countries. Canada has many competent scientists in the field of radio science, who are not at present members of the Canadian National Committee of URSI or its Technical Commissions. Any scientist wishing to attend the General Assembly may get in touch with the chairman of any of the Canadian Commissions covering a field in which he is interested. He should "enroll" with one chairman only, to simplify the bookkeeping, even though he may be interested in other fields as well. His name will then be added to the "Canadian delegation" for the purpose of admitting him to the conference with full privileges. This action is proposed solely to meet the administrative requirements of URSI, and there is no membership fee. Travelling expenses, hotel accommodations, and all the other incidentals of the trip will be the "delegate's" own responsibility.

The Canadian Commissions and their chairmen are as follows:

Commission I — Radio Measurements and Standards: Chairman, Dr. J. T. Henderson, National Research Council, Ottawa.

Commission II — Radio and Troposphere: Chairman, Dr. J. S. Marshall, Physics Department, McGill University, Montreal.

Commission III — Ionospheric Radio: Chairman, J. C. W. Scott, Defence Research Board, Ottawa.

Commission IV — Radio Noise of Terrestrial Origin: Chairman, J. C. W. Scott, Defence Research Board, Ottawa.

Commission V — Radio Astronomy: Chairman, A. E. Covington, National Research Council, Ottawa.

Commision VI — Radio Waves and Circuits: Chairman, Dr. G. Sinclair, Department of Electrical Engineering, University of Toronto, Toronto.

Commission VII — Radio Electronics: Chairman, Dr. H. P. Koenig, Physics Department, Laval University, Quebec.

It would be appreciated if any interested persons would, at their earliest convenience, communicate with the appropriate Commission chairman, so that the names of all participants may be sent to the URSI 1957 General Arrangements Committee not later than February 1, 1957, as we have been requested to do. It is realized that many persons will not have crystallized their plans by that time, of course, and the Canadian Committee is hopeful that flexible arrangements can be made to add names up to the last moment.

A brochure covering the coming general assembly has been issued by the U.S.A. Committee. We believe that you may obtain a copy by writing to: URSI 1957 General Arrangements Committee, National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D.C.

This office would be pleased to attempt to answer any questions you may have regarding the twelfth General Assembly.

J. M. Ann Marshall,
Secretary, Canadian National
Committee of URSI

Calendar

Electrical Engineering

Meetings of all sections in the three divisions of the Canadian Electrical Association, in both Eastern and Western Zones, will be held in Quebec, Que., January 28-31, 1957, and in Vancouver, B.C., March 18-20, 1957.

Information is available from the C.E.A. managing director, B. C. Fairchild, Room 714, Tramways Building, Montreal 1.

Civil Engineering

The American Society of Civil Engineers (33 West 39th St., New York 18) will hold a meeting in Jackson, Miss., February 18-22, 1957.

Materials Testing

Committee week of the American Society for Testing Materials (1916 Race Street, Philadelphia 3, Pa.) is scheduled for February 4-8, 1957 at the Benjamin Franklin Hotel, Philadelphia.

Chemical Engineering

The Chemical Institute of Canada (18 Rideau Street, Ottawa 2) announces meetings as follows:

February 21, 1957, the eleventh Divisional Conference, Protective Coatings Subject Division, in Toronto.

February 22, 1957, Montreal. The eleventh Divisional Conference, Protective Coatings Subject Division.

March 11-13, 1957, seventh Divisional Conference, Chemical Engineering Subject Division, Kingston, Ont.

Library Notes

Additions to the Institute Library
Reviews, Book Notes
Standards

BOOK REVIEW

American civil engineering practice, vols. 1 and 2.

R. W. Abbett, ed. New York, Wiley, 1956. illus., $15.00 per volume.

Written as a successor to Merriman's American Civil Engineers' Handbook, the latest edition of which appeared in 1930, this new comprehensive reference work will be welcomed by all engineers. It presents the fundamentals and techniques of civil engineering planning, design and construction. It is a completely new work, not merely another revision of Merriman's book, and its scope has been considerably enlarged.

Each of the three volumes into which it is divided covers a broad field of civil engineering, and is complete in itself. There are thirty-four sections, each written by an expert. The list of contributors include some of the most distinguished engineers in the United States.

The first volume covers metropolitan and community planning, surveying, highways, airports, railroads, soil mechanics, site planning, foundations, earthworks, tunnels, and mathematical tables. Volume II deals with hydraulic, sanitary and harbour engineering, while the third volume will be concerned with masonry, reinforced concrete, steel, and timber structures.

This volume, used in conjunction with two other works also published by Wiley, Handbook of Engineering Fundamentals, edited by O. W. Eshbach, and Handbook of Engineering Materials, edited by D. F. Miner and J. B. Seastone, will cover nearly all the usual problems, encountered in civil engineering. S.C.

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada.

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

***Aerodynamics propulsion structures and design practice.**

E. A. Bonney, M. J. Zucrow and C. W. Besserer. Toronto, Van Nostrand, 1956. 595 p., diagrs. $11.00.

The series, "Principles of guided missile design", of which this is the second volume, is intended to provide engineers and graduate students with basic information on missile technology. The present volume consists of three sections. Section 1, on general supersonic aerodynamics, deals with such problems as skin friction, shock waves, and loads, and contains material on wind tunnels, ballistic ranges, and flight testing. Section 11 discusses the thermodynamic and aerodynamic principles governing the operating characteristics of jet propulsion engines. Section III covers the design of the airframe and the packaging of its contents. Each section includes a bibliography.

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS

Monday to Friday

9 a.m. — 5 p.m.

Saturday 9 a.m. - 12 noon.

Automatic digital calculators, 2nd ed.

A. D. and K. V. Booth. Toronto, Butterworth, 1956. 261 p., illus.

In this second edition the text has been revised and brought up to date by the inclusion of new material, such as the ferro-electric matrix store and certain automatic coding procedures which have recently been introduced.

The book is intended to serve as a guide to the theory, design, construction and use of digital calculators. The first part contains an historical introduction and an account of the nature and function of the machines. The second part considers the design of calculating machines and their components. The last chapters cover coding and programming, and the uses to which calculating machines have already been put.

The book provides a good clear coverage of the subject, and contains a lengthy bibliography for further reading. It is unfortunate, however, that more detailed references were not given, as some of the items listed are practically impossible to identify.

***Automatic digital computers.**

M. V. Wilkes. London, Methuen, 1956. 305 p., 42/-.

Emphasizing general principles, this book covers design, principles of programming, relay computers, storage, switching circuits, and computing circuits. An introductory chapter surveys the development of computers from Babbage to EDVAC, and the last chapter deals with special problems of design and operation, the organization of a computer center, and applications in business and industrial processes. A detailed description of EDSAC and brief descriptions of other computers are included.

***Aircraft materials and processes, 5th ed.**

G. F. Titterton. Toronto, Pitman, 1956. 398 p., illus., $6.00.

This is a compilation, for engineers and designers, of essential information on metals, wood, plastics, rubber and other materials, and on heat treating, surface hardening, joining, forming and other processes. Numerous suggestions are included on the choice of materials or processes for specific applications. Emphasis has been placed, in this edition, on the effects on materials of heat from aerodynamic heating and jet engines, and changes have been made throughout the text in order to take into account recent advances.

Appraising and integrating employee benefits.

R. D. Gray. Pasadena, California inst. of tech., 1956. 24 p., $1.00 (U.S.) (BIRC pub. no. 3)

Every employer must deal with the problem of employee benefits, and this publication considers how an integrated

program may be developed to serve the needs of both employees and the employer. Since no one system is applicable to every case, the principles of developing such a program are presented.

*Atmospheric pollution, its origins and preventions.

A. R. Meetham. London, Pergamon, 1956. 302 p., illus., 63/-.

This is a general approach to the subject, intended to provide engineers, public health officials and other interested readers with a foundation for more technical studies. It includes discussion of fuel, fuel burning appliances, and industrial processes as sources of pollution, as well as information on measurement, distribution, effects, and remedial measures. This edition includes a new chapter covering pollution in fogs, pollution from nuclear reactions, and recent trends in Great Britain. A bibliography has also been added.

Canadian universities and colleges, 5th ed.

London, National conference of Canadian universities, 1956. 194 p., $2.00.

A directory of Canadian institutions of higher education giving the following information for each: a brief history, lists of administrative officers, degrees and diplomas conferred, grading systems, and special facilities such as graduate scholarships offered, and affiliated schools. Two sections cover special curricula and summer schools. A useful reference book for any library.

Electronic metal locators.

H. S. Renne. Indianapolis, Sams, 1956. 117 p., illus., $2.50 (U.S.)

Although originally developed as mine detectors, metal locators now have a variety of uses ranging from metal prospecting to the detection of metal in food.

This book discusses the three basic types of locator, and explains their operation, construction and application.

A list of manufacturers of electronic metal locators is included in the appendix, as well as a bibliography of periodical articles and books, including a section on the location of buried treasure.

Encyclopaedia of the iron and steel industry.

A. K. Osborne. London, Techincal press, 1956. 558 p., 90/-.

This Encyclopaedia provides, in dictionary form, a concise description of the materials, plant, tools and processes used in the iron and steel industry, and in allied industries, from the preparation of the ore to the finished product.

The work is based on information collected by the author in the twenty-odd years she has been librarian of Brown-Firth in Sheffield.

There are concise definitions of the many terms involved, and a thirty-page bibliography listing the source of many of the definitions.

The appendices include conversion tables, tables of weights and measures, the properties of steels, and a list of societies related to the iron and steel industries.

This is an invaluable work, and should be in the library of anyone connected with the industry — it is, indeed, almost a library in itself.

*Engineering as a career.

R. J. Smith. Toronto, McGraw-Hill, 1956. 365 p., $5.70.

This book introduces the beginning engineering student to the nature of the profession, to the type of studies in which he will be engaged during his four years of college, and to selected topics in civil, electrical, and mechanical engineering. The qualifications, duties, and responsibilities of the engineer are indicated, and the profession is described both in terms of the major branches and in terms of functions—research, design, construction, management, etc. Materials, mechanics, thermodynamics, electrodynamics, and engineering economy are the engineering subjects introduced.

Engineering dynamics. v.2. Elastic problems of single machine elements.

C. B. Biezeno and R. Grammel. London, Blackie, 1956. 527 p., 90/-.

Intended as a graduate text, the four volumes of this work presuppose a knowledge of elementary mechanics and the mathematics connected with it. The book deals with some of the static and kinetic problems which have to be solved by means of the scientific methods of mechanics. The solutions of the problems are given in great detail; consequently there is a limited number presented.

The other volumes in the series have covered the theory of elasticity, steam turbines and internal-combustion engines. This present volume is concerned with the elastic problems of single machine elements, and the topic is considered under four headings: beam and shaft; spring and ring; plate and shell; and problems of elastic instability.

The four volumes are translated from the second German edition which appeared in 1953, and are a valuable addition to the literature on the subject.

*Flow of gases through porous media.

P.C. Carman. Toronto, Butterworth, 1956. 182 p., $6.00.

An integrated and, as far as possible, quantitative account of flow in and through fine-pored media, with emphasis on theory and experimental methods rather than specific applications. Approaching the subject from the Kozeny theory, the author deals in seven concise chapters with such topics as flow through unconsolidated beds, the permeability method of surface measurement, the separation of gas mixtures, diffusional flow, and the transition to turbulent flow. References are listed after each chapter.

*An introduction to fluvial hydraulics.

Serge Leliavsky. Toronto, Longmans Green, 1955. 257 p., illus., $6.00.

A brief summary of various theories, methods, and facts relating to the flow of water in erodible channels. The subjects dealt with include sediment transportation; the difference between traction and suspension; correlation between surface slope and particle size; dunes and ripples; scour criteria; bed-load; side slope stability; and three-dimensional characteristics of the water flow in rivers.

James Brindley: the pioneer of canals.

Laurence Meynell. Toronto, Ambassador, 1956. 190 p., illus., $3.00.

With so much attention focused on the St. Lawrence Project and its attendant ship canal, it is interesting to read this account of the self-taught millwright who was the first great canal engineer in England, and whose first canal was completed in 1761, ushering in a new era in transportation in England. This, the Bridgewater canal, was made even more remarkable by the fact that it was carried on an aqueduct across a navigable river.

Anyone interested in the history of navigation canals would find this an absorbing book, telling as it does of the difficulties encountered in their early financing and construction.

Lectures on the icosahedron and the solution of equations of the fifth degree, 2nd ed. rev.

F. Klein, tr .by G. G. Morrice. New York, Dover, 1956. 289 p., pa. $1.85 (U.S.)

This book covers the solution of quintics in terms of the rotations of regular icosahedron around the axis of its symmetry. It is a basic source book on the mathematics of equations of the fifth degree, and the mathematics of crystallography.

Mass communication.

Erik Barnouw. Toronto, Clarke, Irwin, 1956. 280 p., $4.50.

Television, radio, films and the press are the media covered, with specific application to the United States, although naturally many of the statements apply equally to Canada.

● LIBRARY NOTES

The work is divided into four sections covering history, psychology, the media themselves, and the sponsors of mass communication. This final section includes case histories showing the success experienced through mass communication by businesses, government agencies and non-profit organizations. There are useful bibliographies appended to each section.

The history of mass communication is relatively short, and it is well to be reminded that this is so. The author points out how our way of life is influenced by the constant bombardment to which we are subjected, and how it is largely made possible by the various means of mass communication.

*Mechanics of the roller chain drive.

R. C. Binder with the collaboration of the Engineering Staff of the Diamond Chain Company. Englewood Cliffs, Prentice-Hall, 1956. 204 p., illus., $5.00 (U.S.)

This mathematical analysis of the dynamics and statics of roller chains operating over sprockets provides a basis for developing the power capacity, or rating, of roller chain drives. Among the factors analyzed are centrifugal force, tooth pressure angle, roller velocity, sprocket velocity, chain strand vibration, and the path of the chain strand. The last chapter is an analytical study of a simple type of roller chain drive, made in order to outline a general method for rating drive.

Numerical integration of differential equations.

A. A. Bennett and others. New York, Dover, 1956. 108 p., $1.35 (U.S.)

New methods of integration of differential equations are presented in considerable detail by the authors. These include methods for partial differential equations, transition from difference equations to differential equations, and solution of differential equations to non-integral values of a parameter. The emphasis is on step by step methods of integration.

Oil accounting: principles of oil exploration and production accounting in Canada.

R. E. Waller. Toronto, University press, 1956. 99 p., $5.50.

The rapid growth of oil and gas exploration and production in Canada has resulted in accounting methods being adopted in many cases without due consideration being given to the fundamentals underlying them.

In this book the author outlines the more significant features of oil exploration and production accounting practices, and the concepts on which they are based. Some of the topics covered include cost allocation, depletion and depreciation, income measurement, and statement disclosure.

This book will fill a gap in the published material relating to the Canadian oil industry. It has been produced as part of the programme of the Canadian institute of chartered accountants which is trying to develop accounting literature, especially in fields of special significance to Canadian practice.

Oil pipe line measurement and storage practices.

Austin, Texas University, Petroleum extension service, 1955. 134 p., illus., $3.25 (U.S.)

Published in co-operation with the American petroleum institute, this third volume in a series on oil pipe line transportation practices covers tank construction, strapping tanks, tank gauging and measurement and the quantity measurement of liquid petroleum with meters. An appendix covers the cleaning of petroleum storage tanks.

The book is clearly written and illustrated and should prove useful to all those in, or entering, the petroleum industry.

*Power plants, 2nd ed.

A. H. Zerban and E. P. Nye. Scranton, International Textbook, 1956. 655 p., illus., $8.50 (U.S.)

The new edition of this text, previously published under the title STEAM POWER PLANTS, has been broadened in scope to provide a coordinated treatment of all types of power-generation equipment. The material on internal combustion plants has been expanded, a new chapter on hydro plants has been added, and recent developments such as supercritical vapor cycles and nuclear power are discussed.

*Practical petroleum engineers handbook, 4th ed.

Joseph Zaba and W. T. Doherty. Houston, Gulf Publishing Co., 1956. 818 p., $14.00 (U.S.)

An extensive compilation of tables, charts and formulas connected with drilling and production practice, including sufficient explanatory text material for practical use. There are also separate chapters on general engineering data. About one hundred and fifty pages of new material have been added in this edition.

The physics of nuclear reactors.

London, Institute of physics, 1956. 112 p., 25/-. (British Journal of Applied Physics, suppl. no. 5)

This volume contains the papers and discussions presented at a conference on the subject held in July 1956 by the Institute of physics.

The majority of the papers are by British experts, and cover such topics as the physics of advanced reactors, the zero-energy fast breeder reactor, ZEPHYR; the roles of chemistry and metallurgy in a nuclear energy project; shielding for reactors; the instrumentation of reactors, and United Kingdom research reactors and their uses.

As Sir John Cockroft wrote in his foreword, this is a record of the present state of knowledge of the subject, and of the gaps still to be filled.

Réaumur's memoirs on steel and iron.

Translated by A. G. Sisco. Toronto, University press, 1956. 396 p., illus., $6.00.

Although his name is now best known in connection with a temperature scale and a station on the Paris underground,

● LIBRARY NOTES

Réaumur was an important figure in eighteenth century France. Trained as a mathematician, he was interested in all branches of pure and applied science, and in his Memoirs, which appeared in 1722, is the first published description of the method of changing iron into steel. In this work he also describes the manufacture of malleable cast iron.

In addition to their scientific value, which is considerable, Reaumur's memoirs throw interesting side-lights on the France of the period. Their first appearance in English translation will be welcomed by those interested in the history of science, and by all metallurgists.

Rayleigh's principle and its applications to engineering.

G. Temple and W. G. Bickley. New York, Dover, 1956. 152 p., pa. $1.50 (U.S.)

In this study Rayleigh's Principle is developed to provide upper and lower estimates of the true value of the fundamental period of a vibrating system, or the condition of stability of an elastic system. In this way a useful means of determining frequencies and critical loads is provided.

°Robert Maillart.

Max Bill, ed. Zurich, Girsberger, New York, Heinman, 1955. 184 p., illus., $11.00 (U.S.)

This volume consists mainly of reproductions of photographs and cross section drawings of the structures designed by the Swiss engineer Maillart (1872-1940). Brief comments on the structures and extracts from Maillart's writings, for the most part given in French, German, and English, accompany the illustrations. Although most of the book is devoted to bridges, one section covers other structures, especially those with mushroom column construction.

This is a beautifully produced book, and will be of interest to all our members connected in any way with the design and construction of bridges.

°Science and economic development; new patterns of living.

R. L. Meier. New York, Wiley, 1956. 266 p., $6.00.

The author briefly reviews world needs and resources and discusses possible means of attaining a reasonable level of living for the world's population by the application of recent discoveries in science and technology, particularly in the areas of foods and fuels. He also deals with the possible effects of new technologies on social and industrial organization, and suggests that a "mutant type of scientist and engineer", a scientist-executive, may achieve dominance in the resulting society. Fundamental problems needing solution – the protein supply, low-grade ore utilization, means of transport, and others are listed in an appendix.

Timber design and construction handbook.

Timber engineering co. New York, Dodge, 1956. 622 p., illus., $12.75 (U.S.)

The results of advances in timber design procedures and construction practice are found in this reference book which has been prepared by a research organization long active in the field.

The first chapters discuss the basic properties of wood—its types, grades and methods of preservation. The chapters on design and construction cover preliminary considerations such as load, choice of fastenings, etc.; post-and-beam construction; roof trusses; arches, including lamella roof construction; special framing; outdoor structures; plywood; fabrication, assembly, erection and maintenance. There is a chapter on specification forms, and a compilation of reference data, including weights of different woods, loads, maximum spans, etc.

The final section of the book reproduces the design standards issued by the National lumber manufacturers association, the Timber engineering company, the American standards association and the American society for testing materials. This, needless to say, is a very useful and valuable section.

Much of the material in the book has not been previously published, and certainly little of it has appeared before in such a compact and usable form.

Structural geology of Canadian ore deposits.

Montreal, Canadian institute of mining and metallurgy, 1948. 948 p., illus., $10.00.

This symposium was published to commemorate the fiftieth anniversary of the founding of the Institute. It provides a valuable source of information on Canadian geology, especially those features which control the deposition of ore.

Each chapter is written by an expert, and describes the geology of a particular mine or district. These chapters are grouped together into geographical units, and arranged in three main groups corresponding to the geological regions of the country – the Cordilleran region, the Precambrian Shield and the Appalachian region. There are also general papers on each region, and on the relationship of minor structures to gold deposition.

The book is illustrated with many diagrams, and is well indexed. There are bibliographical references at the ends of many of the chapters.

A technology for the analysis, design, and use of textile structures as engineering materials.

W. J. Hamburger. Philadelphia, American society for testing materials, 1955. 50 p., diagrs., $1.50 (U.S.)

A brief review of the development of textile technology introduces this lecture, which considers the applications of engineering principles to textile research including the elastic behavior of textile materials in tension, compression, binding and torsion. Objective and subjective functional performance characteristics of textile structures are also considered. This is the twenty-ninth Edgar Marburg lecture.

°Transport processes in applied chemistry.

R. C. L. Bosworth. New York, Wiley, 1956. 387 p., $12.00.

This is a theoretical treatment in which the author's concept of a "carrier" is used to explain the mechanism of transport processes: electric current, the flow of heat, diffusion, the transfer of momentum, etc. Among major topics dealt with are coupled transport processes, transport by molecular motion, radiant and convective transfer, turbulent and interphase transport, and irreversibility. The author suggests that unit operations or entire factory operations may be treated as a single, equivalent transport process, and also deals with feedback, cascade operations, and chemical similarity.

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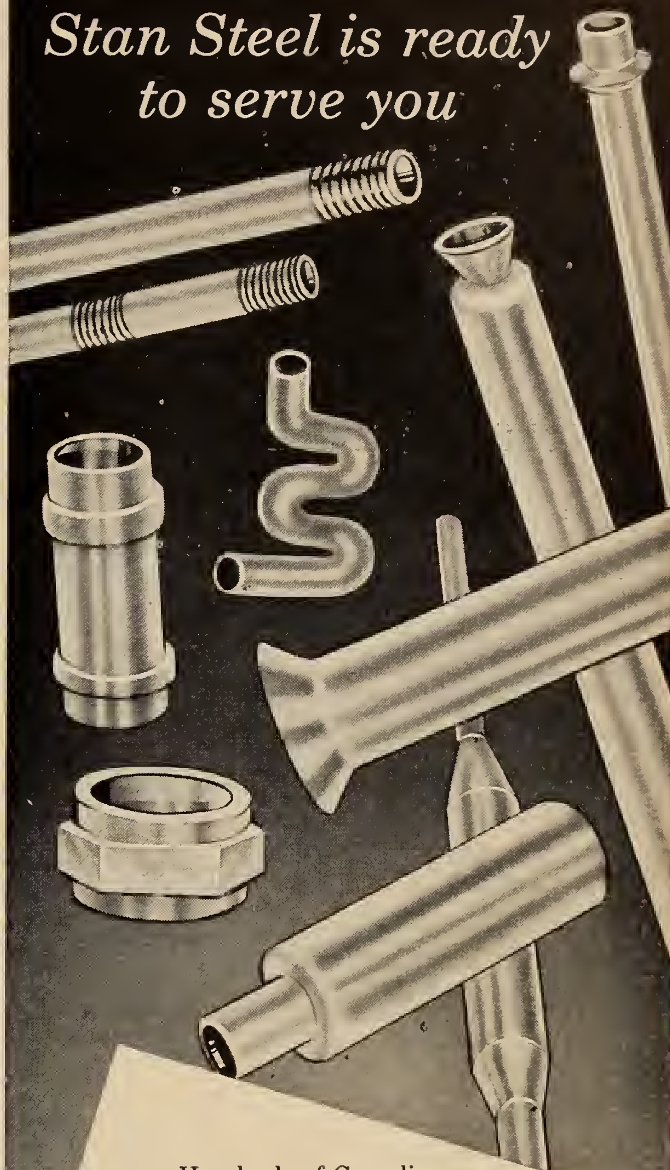

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• LIBRARY NOTES

Workshop for management.

Systems and procedures association of America. Greenwich, Management publishing, 1956. 499 p., $19.00 (U.S.)

Reproduced in this volume are the proceedings of the eighth annual systems meeting sponsored by the Systems and procedures association of America. The Association, founded in 1944, has as its objective the improvement of management in business and industry. Its conferences are designed to keep its members, and others concerned, abreast of current developments in the field.

The emphasis at the conference was on electronic equipment, and some of the topics covered were: surveying present methods and costs before considering the installation of electronic equipment; selecting the right electronic system for the office; training personnel to use the new equipment; organizing the company for an electronics operation; what to expect from the equipment; and when to use manual rather than electronic equipment.

Some of the other subjects discussed were: operations research as applied to production control and inventory management; forms control; work measurement; office incentive plans; records management, etc.

The speakers and seminar participants at the conference were all leading executives, management consultants and electronic office experts: consequently, the information presented is based on actual experience, and represents some of the latest and best information on the subject. The value of the book is increased by the inclusion of a detailed index.

Nuclear power plants.

Nuclear engineering. Calder Hall number Oct. 1956.

Petroleum products.

Storage and handling of liquefied petroleum gases. (Dominion board of insurance underwriters. Standard No. 58)

Sanitary engineering.

Sixth annual conference on sanitary engineering. Transactions, 1956 (Kansas. University. Bulletin of engineering and architecture no. 37)

Steam power plants.

Centrales thermiques. 1956. (La technique moderne. Juillet 1956)

TECHNICAL BULLETINS AND PAMPHLETS RECEIVED

Aircraft industry.

Teddington aircraft controls ltd. Year book. 1956.

Cement and Concrete

Effect of chemical nature of aggregate on strength of steam-cured portland cement mortars. T. Thorvaldson. (Canada. N.R.C. Div. Bld. research. Research paper no. 23)
Recommended practice for winter concreting. (American concrete institute standard no. 52-60)

Climatology.

Climate in relation to frost action. C. B. Crawford and D. W. Boyd.
Dependence of snowfall on temperature. L. W. Gold and G. P. Williams.
New snow and ice research laboratory in Canada. L. W. Gold.
Permafrost research. R. F. Legget. (Canada. N.R.C. Div. bldg research Technical papers nos. 28, 42, 38, 40)

Construction industry.

Insulation of the home. (Canada. N.R.C. Div. of bldg. research. Better building bulletin no. 2.)
Foundations for houses. D. C. Tibbetts.
Good practice in masonry wall construction. H. B. Dickens.
Humidity in Canadian buildings. N. B. Hutcheon.
Soils in house construction. C. B. Crawford.
(Canada. N.R.C. Div. of bldg. research. Building notes nos. 21, 22, 19, 20)

Education.

Liberal education. (Carnegie foundation for the advancement of teaching)
Wanted: 150,000 engineers and technicians; the Waterloo plan. I. G. Needles. (B. F. Goodrich Canada Ltd.)

Electrical engineering.

Gt. Brit. Central electricity authority. 8th annual report. 1955-56.
Picture book of TV troubles. v.7 Sound circuits & L-V power supplies. (New York, Rider, $1.50)

Industrial relations.

Administrative intelligence: our greatest need for good success. T. G. Spates.
Alternative approaches to supplemental unemployment benefits.
M. T. Wermel (California inst. of tech. Industrial relations section. Lecture no. 1: BIRC pub. no. 2)

Geology.

Engineering geology—a fifty year review. R. F. Legget.
A laboratory study of carved clay from Steep Rock Lake, Ontario. W. J. Eden.
A seismic probability map for Canada. J. H. Hodgson.
(Canada. N.R.C. Div. bldg. research. Technical paper no. 36: Research papers no. 17, 22)

Materials testing.

Directory of commercial testing and inspection services in Canada. 3d ed. J. Pohribnei. (Canada. N.R.C. Div. of bldg. research. Technical paper no. 1.)
Journées d'extensométrie. (Groupement pour l'avancement des méthodes d'analyse des contraintes)

Mineralogy.

Development of ore dressing procedures for Canadian ores at the mines branch, Ottawa. L. E. Djingheuzian. (Royal school of mines journal, April, 1956.)
Metallurgical developments in the recovery of some of the less common metals in Canada. L. E. Djingheuzian. (Institution of mining and metallurgy.)

STANDARDS REVIEWED

British Standards, British standards institution, 2 Park St., London, W.1. Also available from the Canadian standards association.

B.S. 84:1956—Parallel screw threads of Whitworth form.

This standard includes tables of basic sizes, limits and tolerances for B. S. Whitworth and B. S. Fine screw threads. An allowance (minimum clearance) is provided on certain classes of bolts of sizes up to and including ¾ in. diameter; the recommended associations of classes of bolts and nuts include nuts having larger effective diameter tolerances than the corresponding sizes of bolts. Three classes of tolerance are provided for bolts, two classes for nuts. No change has been made in the formulae used as a basis for tolerancing effective diameters and other thread elements. 10/-.

B.S. 2772: 1956—Iron and steel for colliery haulage and winding equipment. Part 1—Wrought iron; Part 2—Wrought steel.

These standards cover the requirements of the mining industry in respect of materials for types of load-carrying components of haulage and cage-suspension gear. General requirements for both parts deal with dimensional and weight tolerances, the marking and provision of material for testing, and tensile and bend test requirements. Specific requirements for Part 1 cover "Best Yorkshire", "Special" grade and Grade A wrought iron. Specific requirements for Part 2 cover 25/30 ton carbon steel, 1.5 per cent manganese steel and 50/70 ton tensile steel. The appendices include tables of metric equivalents, forms of B.S. test pieces, and information on "ruling sections". Pt. 1 6/-; Pt. 2 4/-.

The Aviation and Associated Industries

THERE ARE many Canadians, we suppose, who think of our aviation industry as one of our newer and smaller industrial activities. The truth, of course does not bear this out. Right within the borders of our own country, the construction, operation, and maintenance of aircraft have reached proportions which make the field of aviation one of Canada's most important and complex activities. The numbers of personnel engaged, and the millions of dollars spent annually on aviation by this nation, place it well in the front rank of our economy, taking its place with the older ones.

All of this has come about, of course, within the last fifty years, and indeed most of it inside the span of the last fifteen or so—since the beginning of the second world war. Much of the requirement, but by no means all of it, has been military. The war itself, and the long chain of events since, have kept the pressure on for more and more of the latest aircraft capable of carrying out adequate national defence. This demand still goes on, and when it may end is anyone's guess.

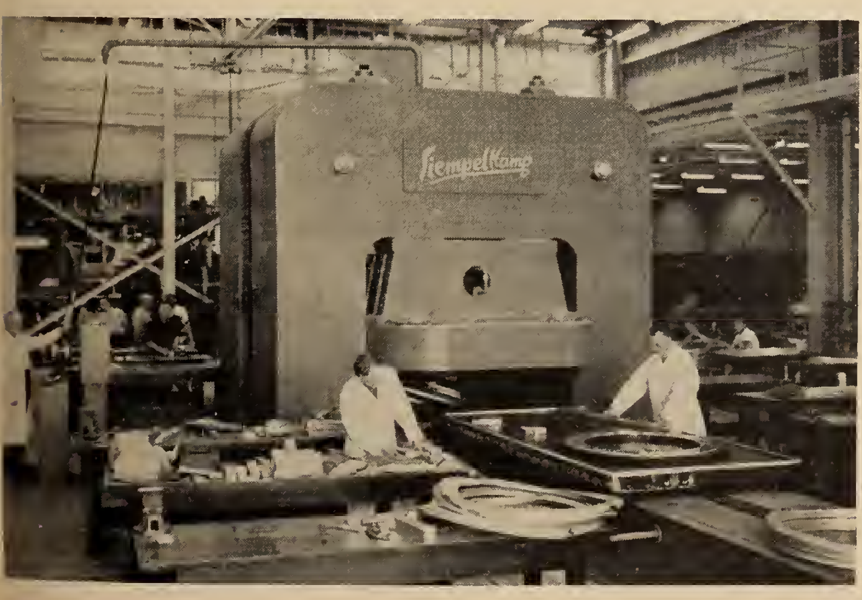
The New Aircraft Industry

The beneficial result of this, so far as the Canadian economy is concerned, has been the creation and expansion of a string of plants for the construction, modification, and repair of aircraft — together with their engines and other equipment—which have commanded the admiration of experts from countries far larger and more experienced than ours. Postwar developments now include the design and production of both aircraft and engines that are wholly Canadian, engineered entirely in this country.

Northern Development

At the same time, another impetus has been added to the aviation industry's expansion in Canada by the new conquest of the North, which is rolling forward with ever increasing momentum. This has brought with it the demand for new and better "bush" type planes, rugged freighters, helicopters, and aircraft specially equipped for mineral exploration. In these fields we have become the acknowledged leaders — Russia of course dissenting!

A large metal-forming press used in the Canadian aircraft manufacturing industry. Sheet metal is shaped over a form by hydraulic pressure, in this case through a 10 ft. by 5 ft. rubber pad at 400 lb. per square inch. Total pressure is 15,000 tons.



Civil Air Transport

While all this has been going on, we must not overlook the developments that have been taking place in our civilian air transport industry. From small beginnings, not too many years ago, Canadians have developed their air carrier business to an enviable position, both domestic and international. Planes of our major air line fleets are familiar sights on any airport in Canada, and on most of the important ones of the free world abroad.

That this varied activity requires hundreds of engineers, and will continue to require them in substantial numbers, is most obvious. It is a technical industry in nearly all of its phases, with places for engineers from several branches — principally aeronautical, civil, mechanical, and electrical. The challenge and adventure of it will appeal to a great many of our young men.

Some of the fields in which engineers are needed are outlined below.

Manufacturing

The manufacturing industries, which are steadily expanding, produce airframes and aero-engines. Associated industries also produce a great range of further equipment which goes into the make-up of a complete aircraft.

The industry is constantly looking forward in design of airframes and engines, and many design engineers are needed in both these fields. Throughout the industry, in fact, designs are constantly being advanced.

Manufacturing processes use much heavy mechanical equipment, such as hydraulic presses for forming sheet metal for airframes, and a wide range of usual and specialized machine tools. Many mechanical and electrical engineers are on operating and maintenance staffs, and other engineers are usually responsible for carrying out the often complex production schedules.

The quality of materials and components in an aircraft must be of the highest order, and quality control is another important field for the engineer.

Operating

The operation of civil airlines also involves engineering staffs. There are many operators, from the large passenger- and freight-carrying lines to those who use aircraft for special purposes, such as survey work. In all cases aircraft must be maintained by technical staffs under the supervision of engineers, though some of the major work may be carried out by the manufacturers.

Mechanical engineers play their part in this work and electrical engineers are widely concerned in the maintenance of radio, radar, and other electrical equipment.

Directly concerned with the operation of aircraft are the airfields and airports which must constantly be developed to keep pace with the expansion of operations. Not only are new areas being opened up, requiring first airfields for the movement of men and materials and later regular airports, but existing facilities rapidly become obsolete if they are to continue to handle an increased volume of traffic and the heavier and faster aircraft being developed, particularly with the wider use of the jet engine.

Though not always directly a part of the aviation industry, many civil engineers are concerned with the building and extension of runways and the construction of airport buildings and facilities, as are engineers in other fields, for example, the provision and maintenance of electrical power supplies and equipment.

Special Operations

Mention has been made of operators of aircraft for special purposes such as survey work. In a great and relatively undeveloped land area such as Canada, exploration and mapping from the air are very important. The discovery and development of mineral resources, abundant in remote areas, is the concern of a rapidly growing industry that uses various aerial survey methods, often with specially-equipped aircraft.

In addition to the engineering staffs required to maintain the flying operations, there is much specialized work in the design and development of, for example, electromagnetic and other survey instruments, and also in the interpretation of survey results.

Aviation plays a great part in the development of Canada's remote territories and mineral resources, which can often only be approached by air until other routes are made. Aerial survey methods represent one of the specialized means of mapping territory and finding mineral deposits. Here, a helicopter handles an aerial electromagnetic survey device with its 20-ft. long "bird".

Research and Development

There is an intense international race for air supremacy, both in the military field and that of civil aviation. As higher speeds and longer ranges are attempted, so must new materials, manufacturing methods, and means of propulsion be developed. Design staffs are working on advanced jet engines and rocket motors. Flight at speeds many times the speed of sound poses countless problems to be solved by the aerodynamics and structural engineers. Complex instrumentation and electronic equipment, for example, for flight control, and so on are the province of the electrical engineer and the engineering physicist.

Administration

Within all the fields mentioned so far there is scope for the engineer to advance through supervisory positions to the higher levels of management. In a specialized industry such as this, the senior managerial posts are often filled by professional engineers.

Training

Most organizations in the industry take undergraduates for summer work.

For the graduate first joining a company, training is always provided to give him the necessary general and specific knowledge to fit him for his future in the industry. Some organizations have set up their own training schools to help to provide the properly trained manpower needed by the industry.

Salaries and Benefits

Salaries start at least at the prevailing industrial level and rise through various scales to the upper levels of management.

Such benefits as paid vacations, pension and health schemes, are usual throughout the industry. Bonus may be paid in certain cases, and some companies, particularly the airline operators, offer travel concessions.

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Contents - February 1957

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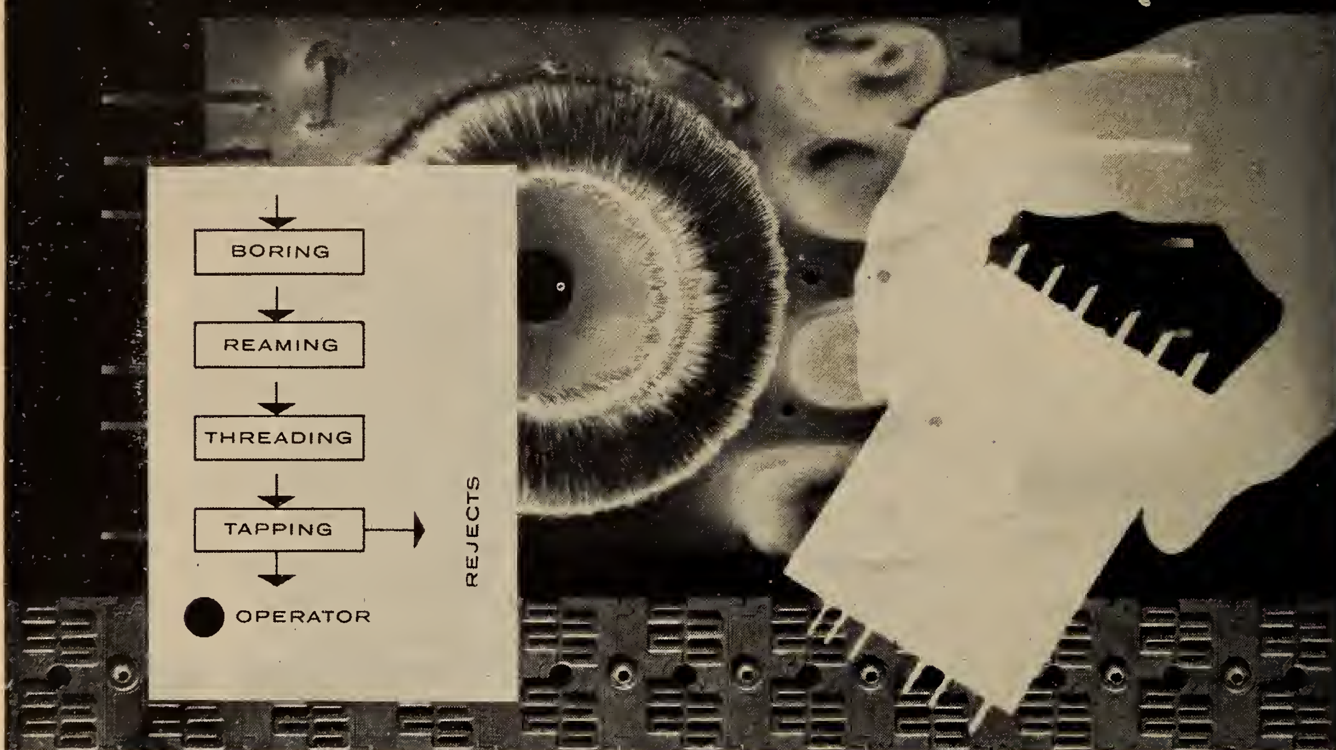

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Canada's Approach to the Economic Fuelling of Nuclear Power Reactors

A. J. Mooradian

Superintendent, Engineering Development Branch, Atomic Energy of Canada Limited

Read at the Biennial Meeting of the Atlantic Provinces Professional Engineers, St. Andrews, N.B., September 1956

The author believes that it is possible to fuel a power reactor to compete economically with present thermal power stations; the heavy-water reactor promises best to give low fuel costs. Work done on fuel problems, particularly at Chalk River, is described in the paper. Results encourage the view that problems will soon be solved.

WE FIND ONE thing in common among all participants in the development of nuclear power. This common focal point is the vision of nuclear power supplying the world with virtually a limitless supply of power at a cost which will allow an unlimited industrial expansion. No serious thinking scientist or engineer will deny this vision.

The popular press and technical publications have allowed the public to share this hope for the future. The 1955 boom in the uranium market is proof of the public's willingness to participate in the development of nuclear power.

However, one cannot help but sense that within the last year some confusion has settled over the clear vision we had in the past. This is nothing more than an indication that the whole field is trying to mature very quickly.

Following the Geneva Conference, there was a flood of declassified information on nuclear power reactors. In the wake of this tidal wave of data, the reactor designers of all countries quietly started to compare their respective approaches to the ultimate goal of the economic power reactor.

Where we found in the past one clear vision, we now found a confusion in the number of approaches to its fulfilment. Where all scientists agreed that it was possible, most designers differed in their approach.

The public, on the other hand, had been so conditioned to the high yield of energy from nuclear fuels that it came as a surprise that anyone should have to make a case for a reactor which would just meet costs of present day coal-fired stations.

There are at least half a dozen different types of reactors which are being seriously considered as power producers. The fundamental variations are largely the result of differences in technical judgment. The same mathematical precision which predicted the possibility of a self-sustaining reactor cannot be brought to bear on the decision as to the best design approach.

It is apparent to those of us in the field that the time is at hand when the nuclear physicist must gracefully relinquish his pre-eminent position in the field of fission reactors.

I would like to quote a passage from a paper prepared by Rear Admiral Rickover, delivered before a meeting of the American Society for Metals, October 20th, 1955. Admiral Rickover is the man responsible for the successful development of the nuclear powered submarine:

> "It is a common belief that atomic power development is primarily the province of the nuclear physicist. Nothing could be further from the truth. What actually faces us is how to determine by calculation and by experiment, the best way to remove heat from a reactor and then to design and build all of the components of the reactor system so that they will operate safely and reliably under the most rigorous conditions."

Economic nuclear power is now dependent on the best answers to the following type of questions:

(*a*) How can a fuel element be made cheaply which will stand up in a nuclear reactor?

(*b*) How can a leak-free system be made cheaply?

(*c*) How can a pressure vessel be made large enough to be economic?

(*d*) What is the cheapest way to get fuel in and out of the reactor?

(*e*) How can irradiated fuel be processed cheaply enough to warrant recovery of fissionable material?

These and a hundred other such questions must be answered by the engineers, chemists, metallurgists, physicists, biologists, and so on.

It is not my intention today to try to cover the whole picture, but rather to give you an idea of how we in Canada are attempting to answer one of the most important of these questions — that of the type of fuel elements which we expect to see in the reactor of tomorrow.

The one aim which all approaches to nuclear power have in common is that of attaining low fuel costs.

The Canadian approach to nuclear power possibly weighs this factor more heavily than most other alternative approaches.

The Chalk River program is based on natural uranium heavy-water moderated reactors. Although it is recognized that heavy water moderation is more economic of fuel than any other type, opponents of the scheme base their criticism largely on the fact that leakage of heavy water from the system at $28/lb. can constitute a crippling expense. Alternatively Canada's confidence in her approach is based on 10 years of successful containment of heavy water and the confidence that the engineering problems of containment in a high pressure system can be solved economically.

The public has been faced by such a barrage of stunning comparisons between the comparative amounts of energy which can be obtained from uranium and from coal that now when nuclear power is asked to compete with conventional fossil fuel stations, it comes as a shock that fuel costs should even appear on the nuclear power balance sheet.

The simple facts are these:

(1) The capital cost of a power reactor will be higher than that of a comparable coal-fired station. For example, the capital cost of a conventional coal-fired station of 100 megawatt capacity today will fall in the range of $120-$160 per kilowatt of installed capacity. The first power reactors of this capacity are expected to fall in the range of $500 to $600 per kw. of installed capacity. It is expected that development of simpler designs and less expensive construction materials and methods should cut this down to $250 per kw. However, it is not likely that reactors will be installed as cheaply as thermal stations in the foreseeable future.

(2) It is also unlikely that the operating cost of a power reactor will be cheaper than that of a coal-fired station. The equipment, controls, maintenance, fuel charging, etc., are all considerably more complex than a conventional thermal station — at least for the foreseeable future.

(3) With operating and capital costs higher than a coal-fired station, the fuel costs will have to be lower than coal in order to make nuclear energy competitive with present day fuel costs.

This then gives us a starting point for a fuel development program by defining the upper acceptable limit of fuel costs. Large base-load thermal power stations burning coal at $8/ton give power at about 5.4 mills/kwh., of which the coal cost is about 3 mills.

To be competitive with coal-fired stations, the fuel cost allowance for power reactors varies according to the optimism of the estimator, but falls in a range covering 1 to 2 mills/kwh.

Now let us see what is being done in Canada to achieve this goal of nuclear fuel costs between 1 to 2 mills/kwh. and to look at the problems which we face in aiming at such a target.

Early in the short history of nuclear development, it was pointed out that the fission of a pound of uranium would yield three million times as much energy as a pound of coal. Even with the higher cost of uranium taken into account, on this basis, it works out that uranium would be about a thousand times cheaper than coal as a fuel.

Now if this were the whole story, the problem would be licked and we could expect nuclear stations to spring up like mushrooms.

Obviously, there is something more to the story.

It turns out that there are a great many expensive problems standing in the way of extracting all of the energy available in the uranium. Some of the limitations are fundamental in nature and some of them are practical.

Fundamental Problems

Natural uranium as mined is a mixture of two isotopes, U^{238} and U^{235}, both of which behave so much alike chemically that there is no separation of the two isotopes in the course of normal chemical processing. Thus, we can take uranium ore and convert it all the way to metal and the relative percentages of the U^{238} and U^{235} do not change.

Now these two isotopes occur in natural uranium in the ratio of 140/1 with U^{238} being 140 times more abundant than the U^{235}. The sad part about these figures is that the most useful of the two isotopes is the one which is the least abundant — the U^{235}.

The fundamental essence of economy in a reactor is the conservation of neutrons. Any neutron which is captured without ultimately being responsible for a fission is a dead loss.

With regard to neutron economy, there is an important difference in the behaviour of the two isotopes of natural uranium. When a neutron is captured by U^{235}, atomic fission occurs, with the expected enormous release of energy. On the other hand, when an atom of U^{238} captures a neutron, it is quietly transformed into an atom of plutonium (Pu^{239}). However, this is not a complete loss because Pu^{239} is itself as fissile as U^{235}. That this, when Pu^{239} captures a neutron it too will release an enormous burst of energy. The net effect is this:

> It takes one neutron to cause fission of U^{235} but it takes two neutrons eventually to cause fission of U^{238}. Thus, U^{235} is called a fissile material, and U^{238} is called a fertile material —fertile because it can be converted into a fissionable material.

With this in mind, we should be in a position to take a look at the important events which are taking place in natural uranium fuel inside a reactor with regard to the fundamental limitations on fuel economy.

(1) The U^{235} is being burned up to give energy which shows up as heat.

(2) U^{238} is being converted to Pu^{239}.

(3) Some of the Pu^{239} is being burned to give energy.

(4) Because the Pu^{239} is not being burned as quickly as it is being formed, there is a net accumulation of plutonium in the fuel element.

In a well designed reactor, it is possible to produce 8 atoms of Pu^{239} for every 10 atoms of U^{235} which are burned. If no other factors were involved in limiting the fuel life, it would be possible to burn about 3 per cent of the total uranium. If we could get the uranium into the reactor at $25/lb. and gave ourselves a 25 per cent thermal to electrical efficiency, the fuel cost would be 0.33 mills/kwh. — well within our target cost.

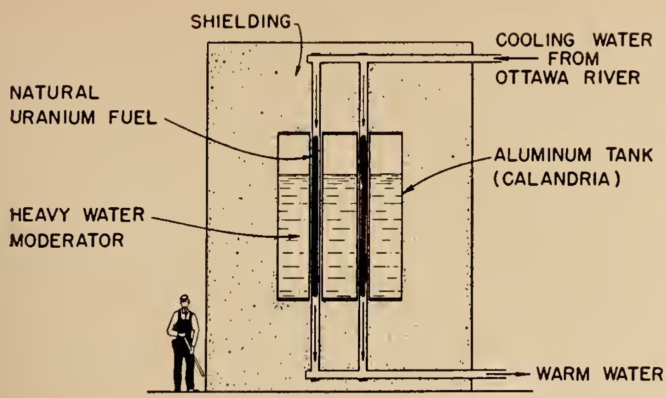
However, another fundamental factor is involved which prevents the attainment of such high burn-up in a single irradiation. This limitation is imposed by the accumulation of the so-called "atomic ash" — the products of fission.

The fission products are neutron parasites. They absorb neutrons without giving rise to either fertile or fissile material. Clearly there is an economic limit to the allowable accumulation of fission products in the reactor.

The nuclear physicists set this fission product poison limit between a burn-up of 4,000 megawatt days/tonne and 6,000 megawatt days/tonne. This corresponds to a cost of between 1.5 - 2.3 mills/kwh., which is within the range of the target figure for fuel.

At this limit, there is a large accumulation of Pu^{239} in the fuel which cannot be economically used because it is associated with the parasitic fission products.

Thus, if the Pu^{239} could be economically separated from the fission products, it would again be a useful fuel. Because Pu^{239} is chemically different from both uranium and fission products, it is possible to make



NRX TYPE REACTOR

Fig. 1. Schematic diagram of the NRX type of reactor.

such a separation by a suitable chemical process.

At Chalk River, we are sufficiently attracted by the possibility of improving the fuel economy by recycling the plutonium that it has given rise to two of our more vigorous programs —that of fuel processing, and that of Pu fuel rod development.

Obviously, there is a practical limit to the number of times the plutonium may be recycled, but it appears likely that fuel processing costs can be made sufficiently attractive to warrant at least a single recycle. One such recycle would allow a net uranium burn-up of 10,000 to 15,000 Mw. days/tonne, giving us fuel costs between 0.6 and 0.9 mills/kwh.

Thus far we have only looked at the fundamental economic aspects of the fuel itself. Other fundamental limitations exist which arise from the necessity of sheathing and cooling the fuel material. These limitations arise because all materials other than fissile or fertile materials are neutron parasites exactly in the same way that fission products are neutron parasites.

Table I shows the price which must be paid to have fuel sheathing and fuel cooling media present in the pile. A similar table was prepared for

Table I*. Irradiation Costs

Material	Irradiation Cost per neutron/kilobarn $/lb.
Lead	0.64
Zirconium	1.5
Magnesium	1.7
Aluminum	5.9
Iron	30
Stainless steel	37
Nickel	55
Oxygen	0
Heavy water	0
Natural water	26

* Based on uranium at $25/lb.

presentation at the Geneva Conference by Dr. Lewis, the vice-president in charge of research and development at Chalk River.

The term neutron/kilobarn needs some explanation. An irradiation of one neutron/kilobarn would be achieved in 116 days (4 months) at 10^{14} neutrons per square centimetre per second. This would correspond to an irradiation of about one year in NRX. The power reactors of the future will probably have neutron fluxes in this order of magnitude.

This means that for every pound of one of these materials we find in the NRX reactor, for example, it would cost the corresponding figure per year of reactor operation.

It is obvious that we are economically limited in the choice of the sheathing and cooling materials which can be used. There are, of course, other technical criteria which further limit the choice of materials.

The comparison in cost between light water and heavy water is also very interesting in that it forms the basis for Chalk River's approach to economic power reactors.

Let me now summarize the fundamental limitations on fuel economy.

First, natural uranium can be taken to a burn-up of 4,000-6,000 Mw.d./tonne before the accumulation of fission products makes further irradiation uneconomic. Assuming we can put natural uranium in the reactor at $25/lb., this would make it possible to produce power at a fuel cost of between 1.5 and 2.3 mills/kwh. if we did nothing more than throw away the spent fuel rod.

However, a further fuel economy can be achieved if the plutonium is separated from the fission products in the spent fuel rod and recycled to the reactor. On such a basis, it is expected that the fuel costs may easily be brought down to 0.6 - 0.9 mills/kwh.

The achievement of maximum burn-up is important in order to get the maximum benefit from recycling plutonium. The longer fuel is in the reactor, the more plutonium will accumulate.

It is clear from what has been said thus far that it is possible for uranium to compete with coal as a fuel within the fundamental limitations of uranium burn-up, but that at present day costs, the advantage is not large.

Practical Problems

Thus far we have talked about the theoretical limits on fuel economy. Now let us see what problems we face in trying to approach these limits in practice.

The primary objective of any fuel rod development program is to produce a fuel rod which will withstand the demanding conditions inside a reactor long enough to attain the fundamental limit on economic irradiation.

The Canadian fuel development program started with the NRX reactor (Fig. 1).

NRX is a heterogeneous reactor composed of uranium rods arranged in a lattice within a tank of heavy water. Each uranium rod is equipped with a cooling channel so that light water can carry away the heat produced in the uranium by fission. The fuel element in this reactor is 10 feet long. Figure 2 shows a cross-section of the NRX fuel element.

The core is pure uranium metal. Surrounding this we have a sheath of aluminum metal and a second aluminum tube. Between the sheath and the tube is the cooling channel which is filled with natural water.

Why aluminum? From Table I, lead, zirconium, and magnesium are more desirable from the neutron economy standpoint. Lead we can discard because it has insufficient mechanical strength and too low a melting point. Magnesium is not sufficiently corrosion-resistant. That leaves zirconium as the chief contender. Zirconium is both corrosion-resistant and sufficiently strong — however, at the time NRX was designed, the technology was not sufficiently advanced to permit the fabrication of such sections.

The light water coolant was selected as a measure to simplify the design.

Probably the most important problem faced by any fuel designer is how to get the heat safely out of the fuel and into the coolant. The heat fluxes involved have never before been faced in this kind of service. A section of an NRX fuel rod about one foot in length, placed in the heart of NRX would generate enough heat to keep seven houses warm through a Canadian winter. Now, if you found that your furnace had suddenly been replaced by a small bulge in the hot water line, you would think that furnace technology had made a tremendous step forward. The NRX reactor is in fact burning up uranium at such a rate and has been doing so for about ten years.

However, although we have been successful in designing for such high heat fluxes, the best we have been able to achieve thus far in NRX is a burn-up of 4000 Mw.d./tonne, and this only infrequently.

Here are some of the problems:

1. *Integrity of the Sheath* — The chief reason that the sheath is provided on the fuel rod is to protect the uranium from corrosion. Uranium metal is very susceptible to corrosion in water, especially when it is hot. In fact chips, turnings, and powder must be kept under oil because of their pyrophoric nature. Now, if for any reason the sheath should rupture, we have a problem on our hands. Not only would the fuel rod quickly corrode away but the cooling system would become highly radioactive.

This faculty of fission products (particularly the fission product gases) to leak through pinholes or small ruptures in the sheathing has enabled the detection of a faulty fuel rod before the fuel element has had an opportunity to cause serious damage.

The hazard of a leak in the sheathing is most serious when the corrosion products build up sufficiently to block the cooling channel. If this happens, the uranium core would quickly melt along with the sheathing and serious damage would result in the reactor.

This problem of sound sheaths has required the development of special test procedures and the most rigid control of production methods. Experience has shown that the seal welds are an important source of failure. To overcome this, Chalk River has developed a crew of aluminum welders whose skill is unsurpassed in Canada.

However, with every conceivable precaution taken to provide sound sheaths, the fuel rods still have to be pulled from the reactor before the theoretical limit of radiation has been achieved. Why?

The reason lies with the effect that radiation and thermal cycling have on the uranium core itself.

2. *Behaviour of Fuel Core Under Reactor Conditions* — Uranium metal behaves peculiarly when irradiated. For example, in the early history of NRX, it was found that some fuel rods shortened, some lengthened, some did not change at all. Not a few thousandths of an inch, but changes in the order of several inches over only a ten-foot length.

Because the reactor itself has to be built to fine tolerances, these dimensional changes have a profound effect on the allowable life in the reactor. If a rod fattens too much, it becomes very difficult to pull it out of the reactor. If it lengthens too much, it can block off the cooling ports.

Obviously, in the early days, there was much information missing which made it impossible to correlate the metallurgy of the preparation of the fuel with its in-reactor performance.

Unfortunately, the only way to proof-test a fuel is to irradiate it in a reactor. The process of accumulating the answers to this problem of fuel life is, therefore, a very costly and time consuming business. However, with NRX, we in Canada are in an excellent position to pursue such important investigations. The NRX reactor is one of the best test reactors in operation in the world today. Sufficient foresight was used in the design to allow for the testing of complete fuel assemblies. Furthermore, the flux density is high enough to give the required data very quickly compared with most other reactors. This explains why NRX has been used so extensively on a co-operative basis by both the United Kingdom and the United States atomic energy authorities. It will interest you to know that the selection of the fuel for the large American power reactor, the so-called PWR, has been made largely on the basis of co-operative experiments conducted in Canada's NRX.

Thanks to reactors such as NRX, we are pretty well in a position to be able to predict the behaviour of a given bar of uranium if we have all of the metallurgical history of the metal. The most striking confirmation of this may be found in the increased life expectancy of NRX fuel elements. In 1947, NRX fuel rods were expected to fail at an irradiation of only 300 Mw.d./tonne, whereas today they have been taken to as high as 4,000 Mw.d./tonne.

The work on NRX fuels has been invaluable in pointing the way to the desirable qualities which we are looking for in power reactor fuels.

Fuelling Problems

We in Canada believe that the route to economic atomic power lies through the heavy-water moderated, heavy-water cooled reactor. This poses some fuelling problems not yet mentioned. For example:

(1) The pure aluminum used for sheathing NRX rods cannot stand up under power reactor conditions. Aluminum (1S) begins to suffer localized intergranular corrosion above 212° F. This corrosion becomes much more serious with increasing temperatures. In power reactors we are asking for corrosion-resistance to water at 600° F.

(2) If the sheath rupture in NRX, the corrosion rate of the exposed uranium is low enough in the cooling water at 70°F. to allow us to shut-down the reactor and remove the damaged fuel before the cooling system has been contaminated or damaged. In 600° F. water, the corrosion of the uranium metal is much too fast to allow a shut-down in time to avoid contamination or damage. Uranium corrodes in water about 100,000 times faster at 600° F. than at 70° F.

Answering The Problems

At Chalk River we are trying to arrive at answers to these two imposing problems. A positive program of development required one important decision at the outset — whether or not the sheath alone was enough protection against fuel corrosion.

On the basis of our own experience and that of other similar projects around the world, it was decided that the risk of sheath failure was too high and that a double line of protection was required. That is, not only would the sheath have to be corrosion-resistant to 600° F. water but the fuel would also have to be considerably more corrosion resistant than the pure uranium metal.

Sheath Materials

Thanks to the vigorous work of the Americans in the development of the *Nautilus* submarine, we have available today commercial quantities of zirconium metal. Table I shows that zirconium is an attractive material as it absorbs only about one-quarter as many neutrons as an equivalent weight of aluminum.

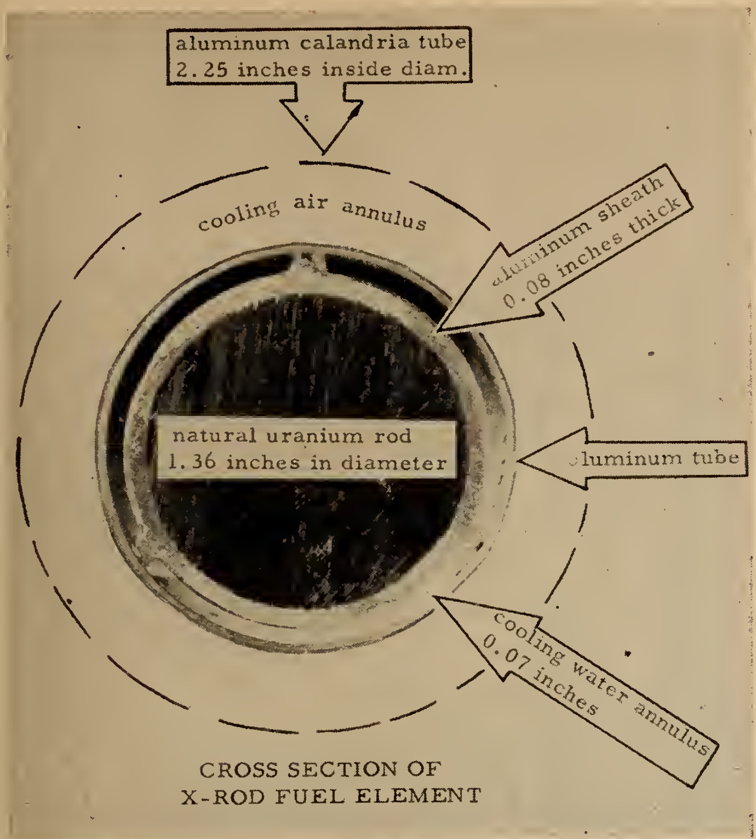


Fig. 2. Cross-section of a fuel element in the NRX reactor.

Furthermore, a zirconium-rich alloy called Zircaloy-II is very corrosion-resistant to 600° F. water.

It would appear that the sheath problem was well in hand. However, this does not prove to be the case. With our aim set at the target figure for economic reactor fuel, fabricated Zircaloy-II at today's prices is prohibitively high in cost, so that sheathing would cost as much as or more than the uranium fuel itself.

However, zirconium technology has advanced very quickly and it is not impossible that costs can be brought within the target range as the technology advances. For example, as late as 1955, the price of zirconium sponge was about $14/lb. On May 3rd, 1956, the *Wall Street Journal* announced that three major 5-year contracts for zirconium had been let by the USAEC for a total of 11 million lb. at an average price of about $6.80/lb. In the face of such remarkably fast development, it is not too much to hope for zirconium at a price which will allow economic sheathing in the foreseeable future.

However, the situation at present is stimulating a search for a lower-cost alloy.

At Chalk River, we have been engaged in such an alloy development program which looks very encouraging. Certain aluminum-rich alloys containing small amounts of nickel and iron have been developed which show remarkable resistance to 600° F. water. Where aluminum itself completely disintegrates under such conditions, this alloy exhibits a corrosion rate of only 1 to 2 mils/yr. However, there is a dependence of corrosion rate on water velocity which arises from the erosion effect. Whether or not this limitation can be overcome will be answered by work which is now in progress. We are very hopeful of a satisfactory solution. This would mean a major break-through in power reactor material technology.

Summarizing the sheath situation, we can say this:

Zirconium exists today and answers the immediate problem of providing something that works. There is considerable hope that zirconium costs can eventually be cut to a level which will make its use economic. This is not so at present; however, developments are in progress which may result in lower-cost alloys which may replace zirconium as a power fuel sheathing material.

Fuel Developments

Now we come to the fuel proper. We have decided, above, that uranium metal has to be replaced by some other form of fuel which will not corrode as quickly as the pure metal in hot water in the event that the sheathing fails.

In the United States there are active programs of uranium alloy development which make use of such alloying constituents as molybdenum to increase the corrosion-resistance of uranium metal. These have resulted in some excellent materials. However, we in Canada hold that it is too costly to introduce such neutron parasites into the fuel and that it would be much more difficult to hit the fuel target costs with such alloys.

The line of reasoning which has been followed is something like this. If the uranium metal is too corrosive, why not corrode the metal first and use a suitable form of the corrosion product as the fuel?

We in Canada are not alone in this approach. Most other atomic power projects have had the same idea.

When uranium metal is exposed to high-temperature water, the resulting corrosion product turns out to be uranium dioxide (UO_2). Oxygen is one of the elements we can introduce into a reactor with practically no absorption of neutrons. This means that uranium oxide is very nearly as efficient a fuel as uranium alone.

The problem is to produce it cheaply enough in the proper form so that we can get the heat out of it without undue distortion of the fuel rod.

Chalk River has joined hands with the Bureau of Mines and a number of industrial firms in order to find an answer. It is not as straightforward as it may first appear.

First, space in the reactor is very expensive. This, combined with nuclear considerations, asks that the best uranium oxide fuels would be those exhibiting the highest densities.

However, it turns out that uranium oxide is an extremely refractory material with a melting point of about 5000° F. so that it is impractical to melt and cast it as fully dense material. The alternative route of compacting and sintering the powder offers a much more attractive possibility. The technology is just at the stage now where various methods are under investigation for producing dense sintered compacts. On a laboratory scale, it has been possible to produce UO_2 at 95 per cent of theoretical density, (approximately 10.59). This density is acceptable

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Plastic Design of Structural Steel

Bruno Thurlimann

Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

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PLASTIC DESIGN HAS not yet much of a history. To take a look into its future may appear somewhat premature. However, such an undertaking offers a possibility to focus attention on this new approach to the general design problem, particularly if we contrast it with present-day elastic methods. In discussing this outlook I would like to distinguish three different aspects:

(1) Theoretical implications
(2) Practical developments
(3) Plans for the immediate future in the United States.

Theoretical Implications

Present-day elastic design methods are completely governed by the concept of allowable stress. This concept is so much hammered into the minds of our students that some honestly believe a stress of more than 20,000 p.s.i. will lead to the immediate collapse of a structure. Even experienced designers are alarmed by some local yielding in a structure. Concentrating all our ingenuity and efforts on more and more refined methods of elastic analysis we forget the actual purpose of design as such.

The purpose of design is not to keep all the stresses in a structure below 20,000 p.s.i — but to produce a structure which will fulfil its intended use without endangering the life of the occupants, the value of the goods stored, and so on.

Elastic design is one approach to the solution of this problem; and, I will admit, a successful one. The great number of existing structures are a visible and convincing proof of its usefulness. Nevertheless, this fact does not imply that it is the only approach possible nor that its application leads to the most economical use of materials.

Let us first take a critical look at the significance of elastic stress calculations. With great accuracy — and very often with considerable mental pain — we determine the stresses in a complicated structure under all imaginable loading conditions. These nominally computed stresses are supposed never to exceed the prescribed allowable design stresses. However, in actual performance under full design loads, some parts will be greatly understressed compared with this analysis while others will be overstressed even to the point where actual yielding occurs. There is ample experimental evidence of the considerable difference between nominally computed stresses and actually induced stresses [1]. However, we should not be astonished about this discrepancy. Firstly, in the stress computations, the presence of residual stresses were not taken into account. Rolled beams for instance, have locked-in cooling residual stresses of from 10,000 to 15,000 p.s.i [2]. Welding produces stresses as high as the yield point value of the material. Furthermore, fabrication operations such as cold bending, cambering, punching of holes, etc., induce additional stresses not accounted for in the analysis. Secondly, during erection, stresses are produced by forcing members into place. The actual sequence of erection causes a different stress distribution than that given by the analysis based on the dead load applied to the completed structure. Assumed simplifications in the analysis constitute a third source of variance between calculated stresses and those actually present. For instance framed structures under lateral loads are commonly analyzed by using either the so-called "portal" or "cantilever" method. Applying both methods to the same problem leads to quite different results. It can be easily shown that the actual stresses do not follow either method.

Concerning the design of connections (either bolted, riveted, or welded) it may appear, at first glance, that it is also based on prescribed stresses which should never be exceeded. Examining the problem more closely will show immediately that parts of the connections will be above, other parts below, these prescribed values. For instance, the end rivets in a row of four to five rivets carry a load considerably above the computed nominal load. Many more examples could be cited in which our present-day concept of allowable stresses is grossly violated.

Considering all these facts you may be compelled to ask "Why then do our buildings actually stand?" May I first answer negatively by stating, "Certainly not because no actual stress exceeds the nominally computed stresses." Recourse must be made to one of the outstanding properties of structural steel — ductility. Steel is able to deform plastically and, therefore, will relieve overstressed parts and bring into play understressed portions. Without this remarkable property our present-day practice of neglecting residual stresses, of using simplified design procedures, and in designing connections could not be justified.

Plastic design philosophy [3] is essentially a conscious acceptance of subconsciously implied justifications of elastic design. The ability of steel to deform plastically is clearly recognized. By forming so-called "plastic hinges" the individual members will develop their full plastic moment value and the structure is able to redistribute its moments. Design is no longer based on an allowable stress concept but on the maximum load carrying capacity — the strength — of the structure as such. By limiting the working loads to a chosen percentage of this ultimate load a safe structure is obtained. It should be mentioned that checks on deflections, stability, etc., are sometimes necessary, as in present-day elastic design, to ensure the proper performance of the structure. However, the essential design criterion for plastic design is the load carrying capacity of the structure.

At present, methods of plastic analysis are fairly well developed for framed structures. All these methods assume that failure will occur due to formation of sufficient plastic hinges to transform the structure into a mechanism. To ensure such a type of failure precaution must be taken to avoid failure by instability. A considerable amount of our efforts at Lehigh is being spent on this problem. We think we have solved the problem of local buckling of rolled sections [4,5]. Work on lateral buckling is in progress. Considerable additional efforts seem necessary in the field of column buckling, especially for cases of framed columns.

Taking a look somewhat beyond the immediate future I feel the biggest progress in structural engineering can be made by a re-examination of the concept of safety. A look back into the past shows that civil engineers should not be too proud about the progress made in this particular field. Around 1820 the French engineer Louis Navier wrote his famous work "Resumé des Leçons" [6], proposing design stresses which should not be exceeded (*loc.cit.* p. 112 to 120). His approach consisted of limiting the elastically computed stresses to a chosen fraction of the ultimate tensile strength of the material. In the case of bending, the stresses computed from the formula $f = Mc/I$ should not exceed 1/10, 1/6, and ¼ of the tensile strength of oak, wrought iron, and cast iron respectively. He arrived at the above given fractions by analyzing the hardiest buildings of his time and comparing their working stresses to the ultimate tensile strength of the material. It should be pointed out that the important building materials of his time were stone, timber, and cast iron; materials having relatively little ductility. By limiting the stresses and hence the maximum strains, the possibility of brittle fracture was eliminated. However, he mentions that ". . . one has not yet conclusive experiments on the resistance of wrought iron against fracture in case of bending" (*loc.cit.* p. 92). In modern terminology we would say that the ductility of wrought iron allows the formation of a plastic hinge.

Today, after more than a century of immense technological progress, we still essentially follow Navier's approach. Even the safety margin for A-7 steel of roughly 20/65 = 1/3.25 (allowable stress/tensile strength) does not differ too much from Navier's recommendations. The major change has been the switch from the ultimate strength to the yield strength as a basis for design.

A re-examination of the safety concept may be started with the question: Why do we need a factor of safety?" In principle a simple answer

> **The author presents the basic thoughts behind the concept of plastic design. Experimental evidence shows that plastic methods can predict the ultimate load of a steel frame with a degree of accuracy on which design can be safely based.**

is possible. A structure should fulfil its intended use without the possibility of collapse, excessive deformations, or any other limit one may choose to specify. Factors influencing this performance are possible variations of material properties, variations in dimensions, quality and control of workmanship, possibility of corrosion, simplifications in design assumptions, possible overloads, etc. All these factors combine to affect the safety of a structure. At present, we use a constant factor of 33/20 = 1.65 against nominal yielding indiscriminately for all types of structures. However, it seems to me not justified to design, for example, a water tank with the same safety factor as a warehouse. The water tank cannot be overloaded (the water will simply overflow), whereas the warehouse may very well be overloaded sometimes during its lifetime. This is just one of many examples indicating that the safety factor should be dependent on the type of structure.

Plastic design philosophy allows a much more realistic approach as it provides methods to compute the actual load carrying capacity of structures. Elastic methods are unable to predict the ultimate load of statically indeterminate structures. They can only specify a nominal load at which first yielding will occur. I have already shown the rather questionable accuracy of such a prediction.

The years ahead should see considerable progress in this field, clarifying the basic issue and leading to a more realistic approach of the safety problem. Important theoretical studies have been made already [7,8]. Especially from the field of aircraft design a good deal of valuable basic information can be obtained. I would like to mention that within our own field new developments in reinforced concrete design take a much more realistic approach [9]. The time has arrived where steel design can no longer afford to relax on its successful past but must get prepared for the future.

Practical Developments

The acceptance of the ultimate load carrying capacity as a new basis for design and with it the introduction of plastic analysis, will bring about changes in the conception, the design, and the fabrication of steel structures. It may be of interest to speculate on this subject.

A strong tendency should develop toward statically indeterminate structures. There are several reasons for such a development. Plastic methods of analysis are much easier and shorter in such cases than corresponding elastic methods. There should be little excuse for avoiding indeterminancy on the bases of too cumbersome an analysis. Even in cases of possible foundation settlements indeterminate systems can be used, for plastic analysis shows that such movements — kept within reasonable limits — do not influence the carrying capacity. Continuity and especially the constant safety factor against ultimate load introduced through plastic analysis will reduce the total tonnage of steel to a considerable extent. May I explicitly point out that elastic methods are unable to furnish a constant safety margin against ultimate load for different statical systems. The higher resistance of statically indeterminate structures against unexpected loads such as earthquakes, bomb blasts, severe damage of individual members should be mentioned as a very desirable feature.

As members, rolled sections will be used primarily. There should be less need for built-up sections with variable moment of inertia, haunched knees, cover-plates, often used in elastic design to reduce peak stresses. Plastic design recognizes the fact that through formation of yield hinges the structure redistributes its forces, relieving overstressed parts and loading understressed portions. For large structures offering difficult conditions for lateral supports — for example, sport arenas, airplane hangars — built-up box sections may offer an elegant and economic solution. Such sections require little lateral support due to their great torsional stiffness. To provide the required continuity of the connections welding is necessary, at least for shop work. At present welding is all too often used as a simple substitute for riveting without giving careful consideration to details. Continuous corner connections, interior two- and four-way connections will present a new challenge to the designer and detailer. Much will depend on the successful solutions of such details to turn the saving in overall weight into a saving of costs. Shop welding should be used to the widest extent possible in building up large sub-assemblies. For instance, an interior four-way connection can be made by welding four beam stubs to the column. In erection, the beam splices, placed at location of low moment, offer considerably less difficulty than a fully continuous beam-column splice. High-tensile bolts may offer a very economical solution for field splicing. Even today high-tensile bolts compete successfully with riveting and welding in field work. In some instances simpler details may be obtained by changing from the usual practice of shear connections (friction between the clamped plates) to direct tension — compression connections, with the bolts in the direction of the forces.

In fabrication, proper care must be taken to conserve the ductility of the material. Punching of holes must be avoided in the tension zones of potential plastic hinges. In the neighborhood of such holes the material is very brittle due to plastic deformations caused by the punching operation. Relatively small strains are sufficient to cause brittle fracture (see, e.g., ref. (10) for informative tests). The same reasons exclude shearing of plates, cold bending of parts and other operations leading to the embrittlement of the material. Small plastic deformations, however, caused by straightening or cambering of members can be tolerated as the material will not lose its ductility.

The general problem of brittle fracture [11] is still with us in spite of the extensive research done since the much publicized failures of the liberty ships during World War II. The structural designer should not expect that the metallurgists will solve this problem completely for him. "Foolproof" steels which will never fail in a brittle manner can be produced. However, their cost is prohibitive for structural application. The present A-7 steel is a perfectly good material if the designer is aware of a few simple facts and pays attention to detail problems. Stress raisers should be eliminated. Special attention must be given to complicated welding details in order to avoid states of triaxial tension [12]. Translated into simplified language this means that material stressed in tension should be able to "breath" at least in one transverse direction. As a consolation to the worried designer I would like to mention that it is extremely hard to produce brittle fracture of A-7 steel, provided the material thickness does not exceed about ¾ inch. Fortunately a large part of our structures fall into this category.

U.S. Plans for the Immediate Future

You may rightly wonder how plastic design may enter the actual design field. I can report to you on the immediate outlook in the U.S.A.

Within the A.S.C.E. a "committee on plasticity related to design" (chairman, Dr. L. S. Beedle, Lehigh University, Bethlehem, Pa.) is working on a "commentary" on plastic design. This document is intended to include (1) the basic assumption of plastic design; (2) experimental data substantiating those assumptions; (3) experimental results of tests on component parts and entire structures; (4) a summary of design recommendations and the background therefor. It is hoped that this commentary can be used by specification writing groups as a basis for a "plastic design" code.

The A.I.S.C. (T. R. Higgins, director of engineering and research) is at present working on a "design manual". (In this connection I would like to mention that the A.I.S.C. together with the A.I.S.I. and the U.S. Navy have been supporting our research efforts at Lehigh University for the past ten years and are continuing their sponsorship.) This book will contain specific examples giving the loading, analysis, detail designs, etc. By introducing an enabling clause into the AISC specification authorizing the use of plastic design if recognized procedures are followed, it is hoped that the new method will find its way into the design offices. It can be expected that such a clause may be incorporated in the specifications within the next one or two years.

After some practical experience in actual application, the A.I.S.C. expects to draft a "plastic design specification" which will be presented as an alternate to its present "elastic" specifications.

Without exaggeration, I say that we have reached a turning point in basic design philosophy. Navier introduced in the early eighteen hundreds the concept of allowable working stresses. For brittle materials such as stone, timber, cast iron — the most important building materials of that time — such a procedure gave a fair estimate of the load-carrying capacity of a structure. As steel found its introduction in building construction during the second half of the 19th century the same basic reasoning was applied without giving due consideration to the great ductility of this new material. Plastic design recognizes this important property by virtue of which a steel structure is able to form plastic hinges and redistribute its moments. It provides a simple tool for determining the actual load carrying capacity on which design can be based. The question "What are the maximum fibre stresses?" is replaced by "What is the ultimate load?" Elastic procedures can only give an answer to the first question — and in most cases a very rough one. Experimental evidence shows that plastic methods can predict the ultimate load of a steel frame with a fair degree of accuracy on which design can safely be based.

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Design and Construction of Earth Dams in Western Canada

R. Peterson, M.E.I.C.

Prairie Farm Rehabilitation Administration, Saskatoon, Sask.

THE PRAIRIE FARM Rehabilitation Administration (P.F.R.A.) was established in 1935 under the Federal Department of Agriculture. One of its main objectives was the creation of irrigation and water development projects to alleviate drought conditions in the three prairie provinces. The original act applied only to that portion of the prairie area known as the Palliser Triangle, but P.F.R.A. activities have been extended to include projects in British Columbia being developed by the Department of Veterans' Affairs.

As most of the projects involved earth structures in the form of dams or canals, it was apparent that engineering soil studies would be required.[6] Consequently a complete Soil Mechanics Division was set up and made responsible for field exploration, laboratory testing, design studies, construction control and, finally, observations of the earth structures in service.

The designs are not based entirely upon theoretical considerations but rather on a mixture of precedent, experience and theoretical soil mechanics.[4] In many instances semi-empirical methods are used to save time and money in the investigation and design stages.

This paper discusses briefly some major points in the design and construction of earth dams with particular emphasis on problems encountered by P.F.R.A. in Western Canada. An attempt is made to cover important recent developments in earth dam engineering rather than repeat information available in existing texts. Typical cross-sections of existing and proposed dams are shown.

With the exception of the smaller dams, where an earth spillway is often adequate, most earth dam projects require a permanent spillway, as well as diversion works and outlet works. These structures usually represent a large portion of the total cost and frequently present formidable design problems. However these considerations are not within the scope of this paper.

Table I is a summary of P.F.R.A. earth dam projects during the period 1935 to 1955 and illustrates the scope of the work.

Table I. P.F.R.A. Earth Dam Projects: 1935-1955.

Height in Feet	No. of Sites Investigated Preliminary	Detailed	Number of Dams Completed	Total
0 – 25	13	70	6500	6583
25 – 75	21	65	76	162
75 – 150	14	17	7	38
150 – 225	6	9	2	17
Total	54	161	6585	6800

Most of the 6500 dams in the height range of 0 - 25 ft. are located on farms and were, in fact, constructed by farmers with only a limited amount of direction and engineering assistance. Soil studies have been made only occasionally for embankments in the 0 - 25 ft. group whereas they have nearly always been required for fills greater than 25 ft. in height. This latter group has involved over 200 sites.

The Travers Dam, typical of the larger earth dams, is shown in Fig. 1. It is a key structure on the Bow River project which will irrigate a quarter of a million acres of dry land in Southern Alberta. The dam is a compacted embankment with a maximum height of 150 ft. in the stream-bed (Fig. 9 (i)) and containing nearly five million cubic yards of fill.

Geology

The entire prairie area with the exception of the Cypress Hills was glaciated and this has resulted in characteristic foundation and borrow problems. Two typical valley cross-sections are shown in Fig. 2. The cross-section at the left shows a valley which has been eroded through the overlying glacial or lacustrian soil into the underlying bedrock; whereas the valley at the right has resulted from down cutting into the overburden only. The bedrock is generally sedimentary; usually soft shale and sandstone with clay shales predominating. In both instances the valleys are filled with river deposited alluvial soils consisting of clay, silt, sand and gravel.

In general, the deposits are relatively soft, stratified and variable and therefore more acceptable as foundations for earth dams than for concrete dams? The variable nature of these formations makes it difficult to establish representative strength, compressibility, and permeability characteristics and consequently the values used in design are often approximations. Terzaghi[12] clearly points out the important effect of minor geologic details on the safety of dams and his definition of 'minor geologic details' as "features that can be predicted neither from the results of careful investigations of a damsite nor by means of a reasonable amount of test borings", is therefore disconcerting.

Medium plastic glacial clay is often plentiful and has proved satisfactory borrow material for the construction of impervious cores and acceptable for homogeneous earth embankments of a limited height. Pervious material in the form of sand and gravel is often scarce and therefore costly.

In order to obtain a better understanding of foundation conditions the geology of all major P.F.R.A. sites is studied by the Geology and Air Photo Division. In addition to providing information on the characteristics of the foundation strata areas of potential borrow material are outlined from a study of air photos.

Design

A satisfactory earth dam design must provide for seepage control through, and stability of, the embankment, foundation and abutments.

Seepage Control

In designing for seepage control, consideration must be given to the quantity of seepage and also to the water pressure and possibility of erosion as a result of the flow.[15] In order to illustrate a number of typical designs, several cross-sections are shown in Fig. 3. These are based on an embankment height of about 60 ft. and it is assumed that the side slopes shown are required from the standpoint of stability.

Impervious Foundation — A zoned embankment with a positive cut-off to impervious foundation material is shown in Fig. 3(a). This arrangement is ideal from the standpoint of seepage control but can be used only where conditions are favourable. The central section of the embankment consists of compacted impervious soil and provides an effective water barrier through the fill. The outer shoulders of granular material provide stability on both sides and drainage on the downstream side. The cut-off consists of an open trench through the shallow pervious material backfilled with compacted impervious soil.

The design shown in Fig. 3(b) is similar to that of 3(a) except that a homogeneous embankment rather than a zoned embankment has been used. This case is common on the prairies where there is often a lack of pervious material and an abundance of impervious material which can be utilized for the homogeneous embankment. In such a design the core or central section is sometimes placed wetter than the optimum moisture content so that it will be able to deform much more than the shoulders without cracking and will also be less pervious. In addition a horizontal filter of screened or select sand and gravel is generally used and a narrow sloping or stepped drain extending at least to maximum reservoir water level has been frequently provided in recent designs.

Fig. 1. Travers Dam; spillway and outlet canal from reservoir in foreground.

Pervious Foundation — A foundation consisting of a considerable depth of pervious sand or gravel as shown in Fig. 3(c) is generally the most difficult from the standpoint of seepage control. Frequently the ground water level is relatively high in such a formation making it costly to construct a cut-off trench to any appreciable depth. It has been established that partial cut-offs are relatively ineffective, and therefore an upstream blanket and downstream drainage is the most feasible method of reducing the quantity of seepage and providing pressure relief. Downstream drainage may be provided by a granular section, filters within the dam, toe drains or relief wells as shown in Fig. 3 or by an inverted filter as shown in Fig. 9(g).

For this type of foundation it is desirable to carry out field permeability or pumping tests to establish the coefficient of permeability. If a reliable estimate of the permeability can be made the proportions of a blanket to reduce seepage to tolerable quantities can be determined by existing methods[14]. Of particular importance in this type of problem is the relation between the horizontal and vertical permeability of the foundation. Where it is impossible or too expensive to establish reliable permeability values the blanket is generally proportioned on the basis of empirical rules. For the average case a blanket equal in length to approximately 10 times the water head is utilized. Among the important considerations in proportioning the blanket are the permissible seepage loss through the foundation, the effectiveness of the natural blanket in the upper layers of the foundation at the site and the possibility of silting in the reservoir.

During the past few years the use of relief wells[18] has increased and this method appears to offer very satisfactory seepage control, particularly where the surface soil is less previous than the underlying material. The U.S. Engineer Corps has carried out extensive research in connection with design and construction of relief wells. These studies have indicated that substantial penetration into the pervious foundation layer and length of screen are more important variables than well size and spacing in achieving maximum pressure relief. In order to avoid corrosion problems the Engineer Corps are utilizing slotted wood stave pipes surrounded by gravel packing. At the present time the P.F.R.A. is carrying out tests to determine the best type of well for use under western conditions. Installations to date have included standard well screens and slotted steel and plastic pipes—with and without gravel packing. For limited depths risers fabricated by nailing four 1 x 4 plywood strips (slotted with a circular saw) into a rectangular conduit have proved very satisfactory. Perhaps one of the most important advantages of relief wells for seepage control beneath dams is the fact that a few wells can be installed in the early stages and more added if the need for further relief is indicated by high pressures in the toe area. Inverted filters can also be added at the downstream toe to stabilize boils and prevent erosion due to seepage flow.[16, 20]

The gradation of interior filters, weighted filters and packing around relief wells must be such as to retain the particles of the material to be drained but coarse enough to be many times more permeable than the material to be drained. These requirements will be met if the 15 per cent size of the drainage medium is at least four times the 15 per cent size of the layer to be drained and is not more than four times the 85 per cent size of this layer.[35] In order to protect embankment and foundation material, it is sometimes necessary to use several filter layers based on the above rules. However, on the majority of projects where the material to be protected is fairly well graded, one filter layer is considered sufficient. Where two filter layers are required an attempt is often made to utilize a similar gradation to fine concrete aggregate and to coarse concrete aggregate as these sizes are generally easily available. In some cases, however, special gradations are absolutely essential but are difficult to produce, particularly in the sand sizes. One point of considerable importance in the design of filters and weighted filters has to do with the relative permeability of a pervious foundation layer and the filter itself. It should be remembered that the foundation material is quite frequently in the loose or medium density state and stratified. The horizontal permeability is therefore considerably greater than praise the situation at two other dams at which sheet piling was used. At the Fort Randall dam an upstream blanket and relief wells were used instead of a sheet pile cut-off and reports indicate that this design is performing very well.

In commenting on the effectiveness of steel sheet pile cut-offs Bureau of Reclamation Engineers state.[22] "Steel sheet piling was used at both Pine View and Rye Patch Dams, but exploration and operation exper-

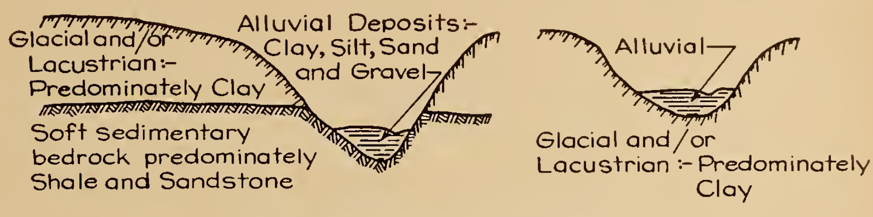


Fig. 2. Typical valley cross-sections.

the permeability of the same material when mixed and compacted to even a medium density. This generally means that if foundation sands and gravels are to be considered for filters they must be washed or processed in order to make them many times more pervious than the foundation material in place.

Sheet Pile and Concrete Cut-offs —On early projects in the west considerable use was made of wood sheet piling for cut-offs. In some instances this sheeting was driven, in others it was dug in and backfilled. Steel sheet piling has also been used and its effectiveness is being studied. The initial studies were required in order to design a 200 ft. earth embankment resting on a foundation of 100 ft. of fine to medium sand (Fig. 9(a)). Laboratory tests indicated that the interlocks of commercial steel sheet piling were far from watertight and that the sheet piling would be relatively ineffective, particularly where the seepage path beneath the dam was great.[17] On the other hand observations on the drop in water pressure across a sheet pile wall beneath an existing 16 ft. dam indicate that the wall is completely effective. In connection with appraising the effectiveness of steel sheet piling a review of the designs for the major dams on the Missouri River was particularly informative. At the Fort Peck Project steel sheet piling was used; however, observations indicated that it was not effective and relief wells were required at the downstream toe.[19] Sufficient records are not yet published to apiences have shown this device to be relatively ineffective."

On P.F.R.A. earth dam projects concrete core walls or concrete cut-offs have not been used. In only one instance has it been necessary to grout the bedrock beneath a compacted earth cut-off.

Abutments — Abutment treatment has proven to be important and critical on many projects. Frequently the soil or bedrock in the abutments is stratified and this may permit horizontal flow around the end of the cut-off. In addition the contact zone between the overburden and the bedrock is often pervious due to the presence of sand and gravel and because of weathering in the bedrock material. Such conditions require the use of special drains on the abutments. However, it is often necessary to wait until the reservoir is filled in order to determine the required size and location of these drains.

Stability

In general terms, the stability of an earth dam means the ability of the structure to retain its shape. It is common practice to check the stability of a dam by one of several methods of analysis. The general procedure is to select a segment or slice at right angles to the axis of the embankment and assume a potential sliding surface in the dam or the dam and the foundation. A major problem is the choice of the shear strength[27, 33] that can be mobilized in the several soil types involved and the pore water pressures that might exist due to seepage or compression of the soil. In the case of a compacted embankment, an estimate of the shear strength can be made in advance of construction but it must be recognized that this strength may or may not be realized. For example the water content and degree of compaction may vary during the placing operation from that assumed in design and this will result in a different strength and different density from that anticipated.[8] Also the type of fill material used may differ somewhat from that initially envisioned. Similarly the actual strength of the foundation may be at variance with that estimated for design purposes. Rate of construction and the resultant consolidation exerts a great influence on the shear strength of soils and if this and drainage conditions are not accurately envisioned, the selected design shear strength may be considerably in error. When the choice of shear strength has been made the stability analysis is more or less routine.

Methods Used for Stability Studies — The Swedish method which assumes a potential slide on a circular arc is commonly used in stability studies. In cases where the shear strength of each soil strata is assumed constant the stability is evaluated by taking moments about the centre of the arc as shown in Fig. 4(a). The overturning moment is the weight of the soil mass times the moment arm and the resisting moment is the total shear strength along the arc times the radius. For the more complicated case where it is assumed that

$$s = c + (p - u) \tan \varnothing$$

(s = shear strength, c = cohesion, p = total unit pressure on the surface of sliding, u = pore water pressure, and $\varnothing$ = true angle of internal friction) it is necessary to consider the variation of shear strength along the arc. This is done by dividing the segment into slices and summing up the forces on the individual slices or else resorting to the integration or area method.[28, 34] The most critical arc is found by trial and error.

Another method which can be used is the sliding block analysis. This method applies particularly to the case of spreading on a weak horizontal layer in the foundation.[23, 35] The forces involved are shown in Fig. 4(b). The active earth pressure (which tends to produce movement) is equated with the passive

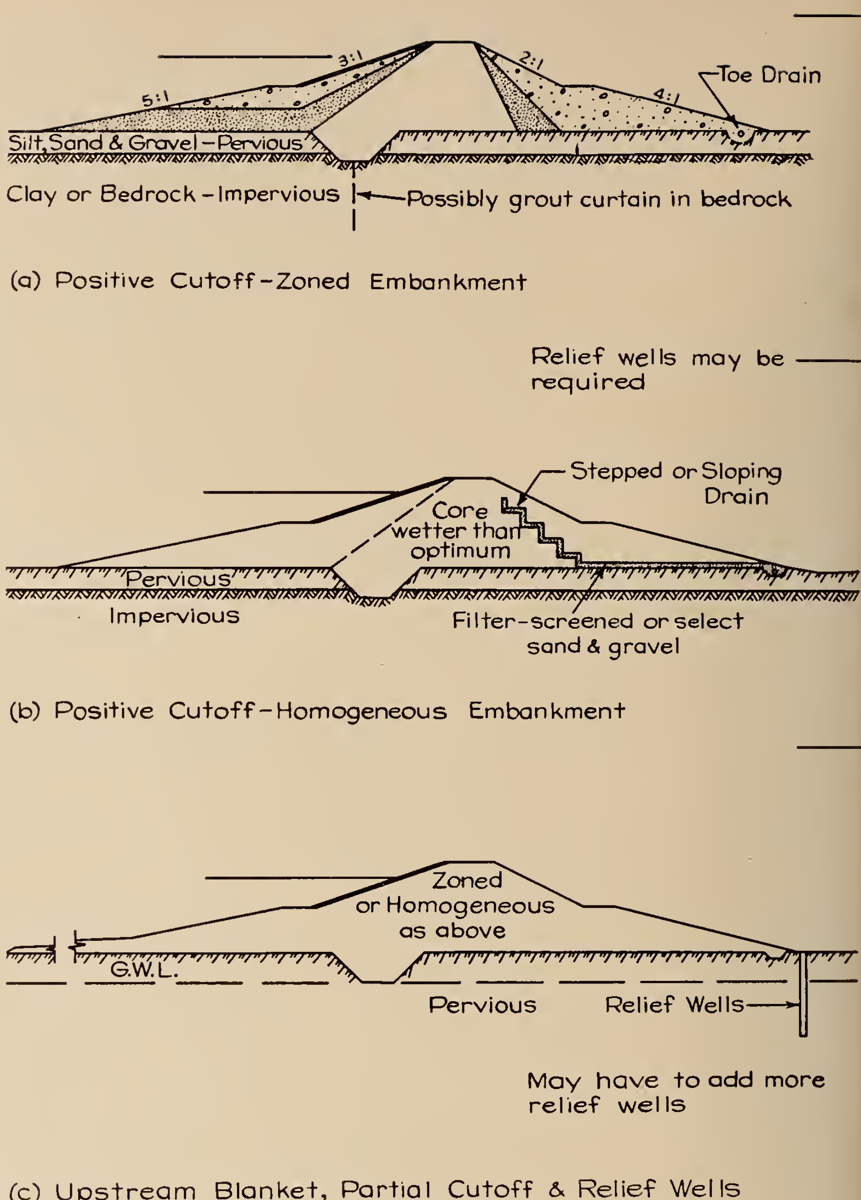


Fig. 3. Typical methods of seepage control.

pressure plus the shearing strength of the soil on the assumed plane, both of which tend to resist movement. The most critical condition is determined by trial and error.

A third method of evaluating stability is known as the elastic analysis in which the stresses within the foundation are computed on the basis of the theory of elasticity and these stresses are compared with the available soil strength.[31] There is always some question as to whether or not the foundation behaves in an elastic manner and this method has been used only for special conditions.

Conditions Checked — Any, or all, of the above methods can be used to check several critical conditions which may occur during the construction or operation of an earth dam. Frequently the most critical condition is the stability immediately after construction, particularly where clay soils are used in the embankment or thick clay layers occur in the foundation. For such an analysis it is generally assumed that the shear strength of clay is equal to one-half the quick or undrained compressive strength and the computations are carried out using total stresses. Based on experience in Western Canada it would seem that this method is on the unsafe side when applied to highly plastic clay foundations as several slides have occurred where the estimated factor of safety was in excess of 1.5.[2, 32, 36] The reasons for this are not yet evident and research is being carried on in an effort to explain this apparent discrepancy.[24] It would appear that the strength of the clay at very low rates of strain or under sustained load at constant water content may be appreciably less than that determined by conventional quick or undrained laboratory shear tests[25]. Furthermore there is a possibility of progressive failure or incompatibility between the foundation material and the embankment material when they have different stress-strain characteristics. Quite frequently embankment materials are placed at lower moisture contents and may be more brittle than the wetter foundation clays. There is also some reason to believe that the embankment material may become more brittle with the passage of time. Where such conditions exist the foundation may deform and before the full strength of this soil is mobilized, failure may occur in the more brittle embankment. Following this the entire load must be carried by the foundation and deformation is certain to increase with the likely possibility of failure.

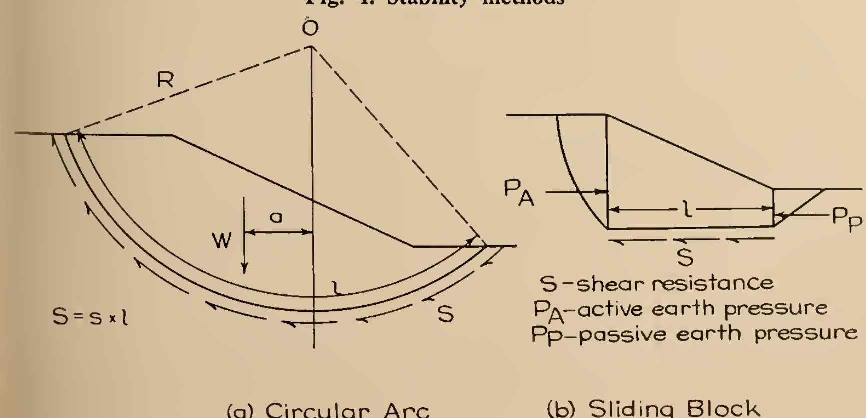
The second condition which may be critical is the case of a dam with a full reservoir and the seepage line developed through the embankment. In such an analysis the effective stresses are generally used and the pore pressure is estimated by means of a flow net. In order to apply the method of effective stresses, it is necessary to know the true cohesion and angle of internal friction of the soil which can be determined by the slow or drained shear test. These tests are time consuming and some investigators in the past have estimated the value of the true angle of internal friction $\varnothing$ since it did not appear to vary greatly for different soils. Frequently estimates of $\varnothing = 30°$ have been utilized. However, recent studies at Harvard [24] have indicated that this value may be 20° or even lower for some of the highly plastic clays.

The third condition which should be considered is the effect of rapid drawdown on the upstream slope. The results of consolidated quick tests are required when this analysis is carried out on the basis of total stresses. It is interesting to note that the overturning moment is almost doubled following rapid drawdown whereas the strength of clay soils remains approximately the same. A failure of this type would not be as serious as the others and therefore a lower factor of safety is justified.

Factor of Safety — A numerical value for the factor of safety in some cases implies a degree of accuracy which does not exist. First of all there are inconsistencies in the definition of safety factor. If it is defined as the ratio of the resisting moment to the overturning moment the value will vary depending on whether the resisting moment includes only the resistance due to soil strength or due to both soil strength and that portion of the mass which tends to resist the overturning moment. In order to avoid this inconsistency it has been suggested [2] that the safety factor be defined as the ratio of the soil strength available to the soil strength required. There are also many variables affecting shear strength, and other important conditions which must necessarily be neglected in making a stability analysis. Consequently the numerical value obtained is really only an estimate of the relative safety.

A review of the literature leaves one with the impression that the computed safety factor of an earth dam should be at least 1.5 for the condition immediately after construction or with seepage developed as a result of a full reservoir. This would seem to apply for granular soils and other types where the characteristics can be predicted with reasonable accuracy. Where the soils are more erratic, of a clay type, or where less desirable conditions prevail, then higher values of the factor of safety should be used. In view of the discrepancy between theoretical analyses and field behaviour, and until such time as more complete information is obtained, P.F.R.A. is attempting to use factors of safety of at least 2 and preferably 2.5 for cases where highly plastic clay foundations are involved. This is based on conventional tests applied in the usual manner; if adjustments are made in the shear value for slow rates of strain and progressive failure the above suggestions are undoubtedly too conservative.

Fig. 4. Stability methods



Settlement — Compression of the embankment and settlement of the foundation can generally be predicted with reasonable accuracy from the results of consolidation tests, at least where soil conditions are uniform. However, the rate of consolidation is much more difficult to predict because rate of drainage through sand lenses, fissures, etc., is difficult to evaluate or predict from laboratory tests.

Slope Protection — Slope protection is of major concern on the portion of the upstream slope between low water level and the crest of the embankment. In this zone dumped riprap placed on a coarse gravel blanket appears to be the most desirable method of protection.[26] The downstream slope and the upstream slope below operating water level are generally left unprotected or are protected with gravel blankets or the gravel of a zoned embankment. In some instances the downstream slope is covered with topsoil and seeded.

Embankment Cracks — One of the most important points brought to light in recent years is the possibility of cracks forming through an embankment at right angles to the axis. This danger has been pointed out by Casagrande [3] and by Sherard.[11] Fig. 5 shows the areas where cracks might occur. In the case of one otherwise well constructed dam Sherard attributes the formation of a transverse crack to stretch which occurred along the longitudinal axis. Reference points had been placed 100 ft. apart along the crest and a stretch or elongation of as much as 6 in. was measured between two successive stations. It would appear that differential settlement within a fill, or adjacent to steep abutments or closure sections, can cause tension along the top of the embankment resulting in elongation of the crest and crack formation. Sherard's studies of a considerable number of dams seem to indicate that certain silt and clay soils compacted on the dry side of the optimum are most susceptible. Fig. 6 shows a photograph of cracks which have developed due to non-uniform settlement within a homogeneous embankment 30 ft. in height. The cracks shown are two to three inches in width and resulted from a subsidence of approximately one foot in an area about 30 ft. to the left of the photograph.

In order to avoid such cracks in embankments uniform compaction and moisture content are desirable. Abutment treatment to eliminate steep slopes and overhangs is important in eliminating the danger of differential movements conducive to cracking. It has been suggested that the best protection against piping through such cracks would be the use of a zoned fill. However, where it is necessary to use homogeneous fills it is believed that a central section compacted wetter than optimum may form a plastic core which will not crack as a result of movement.[3] Another precaution that might be taken in connection with homogeneous embankments is the use of a pervious filter layer extending for the full height of the embankment. Such a layer would intercept any seepage through cracks and would likely prevent failure due to piping.

Abutments — The treatment of abutments is of major concern on many projects where glacial material or unstable clay shale [10] is involved. Fillets between the embankment and abutments or widening the ends of the dam can be used to stabilize weak abutments. The strength and stability of abutment materials are quite frequently evaluated on the basis of the long time performance of the existing slopes making due allowance for altered water conditions which will result from reservoir seepage; rather than by laboratory testing and theoretical studies.

Construction

Foundation Treatment

Foundation treatment is difficult and controversial in the case of many of the sedimentary bedrocks encountered.[42] Frequently where the bedrock is soft shale or sandstone the foundation and cut-off trench is trimmed with ordinary earth moving equipment and the first layer of embankment placed directly upon this surface. However, where the foundation consists of harder interbedded shale and sandstone which is fractured and weathered, the preparation and clean-up is troublesome and frequently decisions regarding the required depth of excavation are difficult. In such cases a hand clean-up is generally specified and it would appear desirable to place a layer of Gunite, such as was used at the Kenny Dam [37], particularly if there is any possibility of grouting being required at a later date. It is important to place the first few layers of impervious embankment somewhat wetter than optimum with a view to securing better compaction and contact against the foundation.

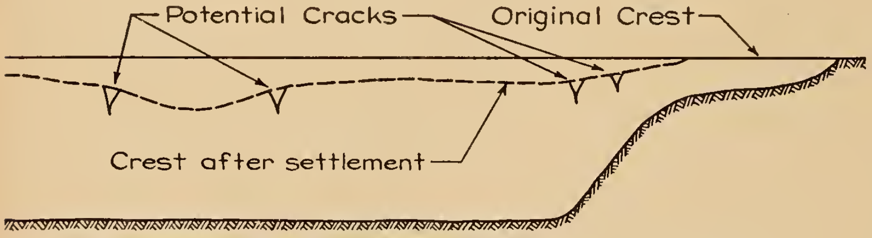


Fig. 5. Embankment profile showing areas of potential cracks.

Placement of Embankment Material

Impervious — The placement of impervious embankment material is perhaps the most important construction consideration.[43] When the P.F.R.A. began its program of earth dam construction in the drought period of the thirties there was very little water available to moisten impervious soils to the proper water content for ideal compaction. Because many of the earlier and lower dams were of necessity compacted without the addition of water and therefore below the optimum moisture content, a few failures were experienced.[40]. These failures generally occurred on the first filling of the reservoir by piping through dry poorly compacted layers. Fig. 7 is a downstream view of a pipe through a low earth dam in which compaction was poor due to low placement moisture content. As the program developed special precautions were taken to ensure moisture control during compaction. It was found that irrigation of the borrow pits in advance of construction was by far the most satisfactory method where more than 3 or 4 per cent moisture had to be added. Experience indicated that when a borrow pit was excavated a few weeks after irrigation the moisture content would be almost at the optimum for typical medium plastic glacial soils. In the case of higher dams, however, it is most important that the moisture content be no greater than optimum otherwise there is a danger of high pore pressures within the fill during construction.[30, 39]

Compaction of impervious soils for earth dam construction by means of sheepsfoot rollers would seem to be more desirable than compaction by other methods. However, in recent years the use of rubber tired rollers has become more prevalent.[38] When using a sheepsfoot roller it is common practice to compact the material in 6 in. lifts by 8 to 12 passes of the roller whereas for the heavy rubber tired rollers, the thickness of lift can be doubled and the number of passes reduced to about half. However, uniformity of the soil as placed is of paramount importance and the sheepsfoot roller is somewhat superior to the rubber tired roller in this regard as it produces a more intimate mixing of the soil and the moisture within the material. In addition the "puckered" surface left by the roller feet results in better bond between layers.

Pervious—The placement of pervious fill has not involved any serious problems and compaction is generally carried out in layers about one foot in thickness utilizing either crawler tractors, earth moving equipment or rubber tired rollers.

The addition of moisture has not proved necessary with most sand and gravel selected for embankment use. In some instances the finer more uniform sands would perhaps have benefited considerably from the addition of water during compaction.

However, where structures have been placed on compacted sand and gravel moisture control and thin layers have always been used.

Test Apparatus

Special emphasis is placed upon the use of observational or test apparatus to study the behaviour of earth embankments and this equipment is generally installed during construction. The several types now being used are shown in Fig. 8.

The Bureau of Reclamation has successfully developed a good deal of apparatus used for this purpose.[1] The B. of R. settlement gauge which has been adopted by P.F.R.A., makes it possible to determine the settlement of the surface of the foundation and also the compression within the embankment by lowering a measuring bob through a gauge consisting of telescoping pipe with cross arms.

Piezometer equipment [1] consisting of tips within the embankment and foundation is utilized to measure pore pressures. The tips are connected by double lines of plastic tubing to a terminal well located at the toe where the pressures can be read continuously on bourdon gauges. In addition perforated standpipes and piezometers are used to check the water level in the downstream portion of the embankment and in the vicinity of the downstream toe in the foundation. In order to study surface movements on the crest of the dam, on berms and at the downstream toe, alignment pins as shown in Fig. 8 are being used. A more recent development utilizes plastic casing and an inclinometer to detect horizontal movements at any point along the length of the casing within the embankment, foundation or abutments. This method was developed by Wilson and is being tried on several projects.[41]

Stage Construction

Many earth dams are founded on soft alluvial materials, with highly plastic clay being predominant. If there is any possibility of gain in strength due to consolidation within a reasonable length of time, stage construction is always considered, although the results are often uncertain until field observations are available. At the present time six embankments utilizing stage construction have been recently completed or are being built by P.F.R.A. (Fig. 9(e)) and an equal number are proposed (Fig. 9 (c)). The importance of having readings of test apparatus available is obvious in making decisions with regard to the safe rate of construction.

Concluding Remarks

It is probable that the soil mechanics literature may leave one with an incorrect perspective of the limitations of soil mechanics theories in practice.[3] This perhaps is more often the fault of the reader or student rather than the writer, as the authorities on the subject invariably warn of the practical limitations of the theories as a result of erratic soil conditions and other considerations which might not comply with the basic assumptions. It would appear that the student masters the theory and in his zeal to apply it often neglects to consider fully the many limitations imposed by variable and indeterminate soil conditions.

There is no doubt that the science of soil mechanics has resulted in tremendous progress in the field of earth dam engineering. However, very serious gaps in our knowledge still exist. Perhaps the most important of these is the shear strength of clays and particularly the time effects associated with these soils. Much study and research coupled with field observations are required for a better understanding of these problems. One must be careful not to rely upon new methods or procedures until they have been proved in practice. In the case of earth dams, where failures may involve high property damage and loss of life, it is generally impossible within a limited period to check the validity of theories by study of full scale models. If there is any reason to suspect the theory or the experience on which a design is based or to question the safety of an earth structure, the wise course is to rely heavily upon field observations to warn of dangerous conditions. This makes it possible to modify the design to include berms, flatter slopes, relief wells or stage construction and thus achieve a safe yet economical structure.

In conclusion, P.F.R.A. design and construction methods are based on soil mechanics, accumulated experience, and precedent, with consider-

Fig. 6. Cracks in crest of homogeneous earth dam.

Fig. 7. Pipe through low earth dam.

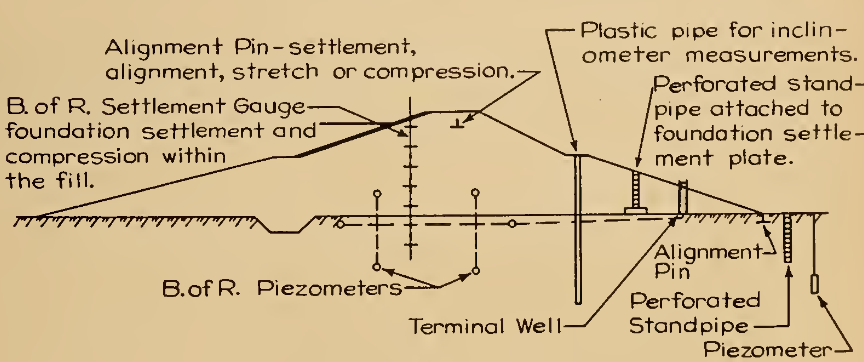


Fig. 8. Typical test apparatus.

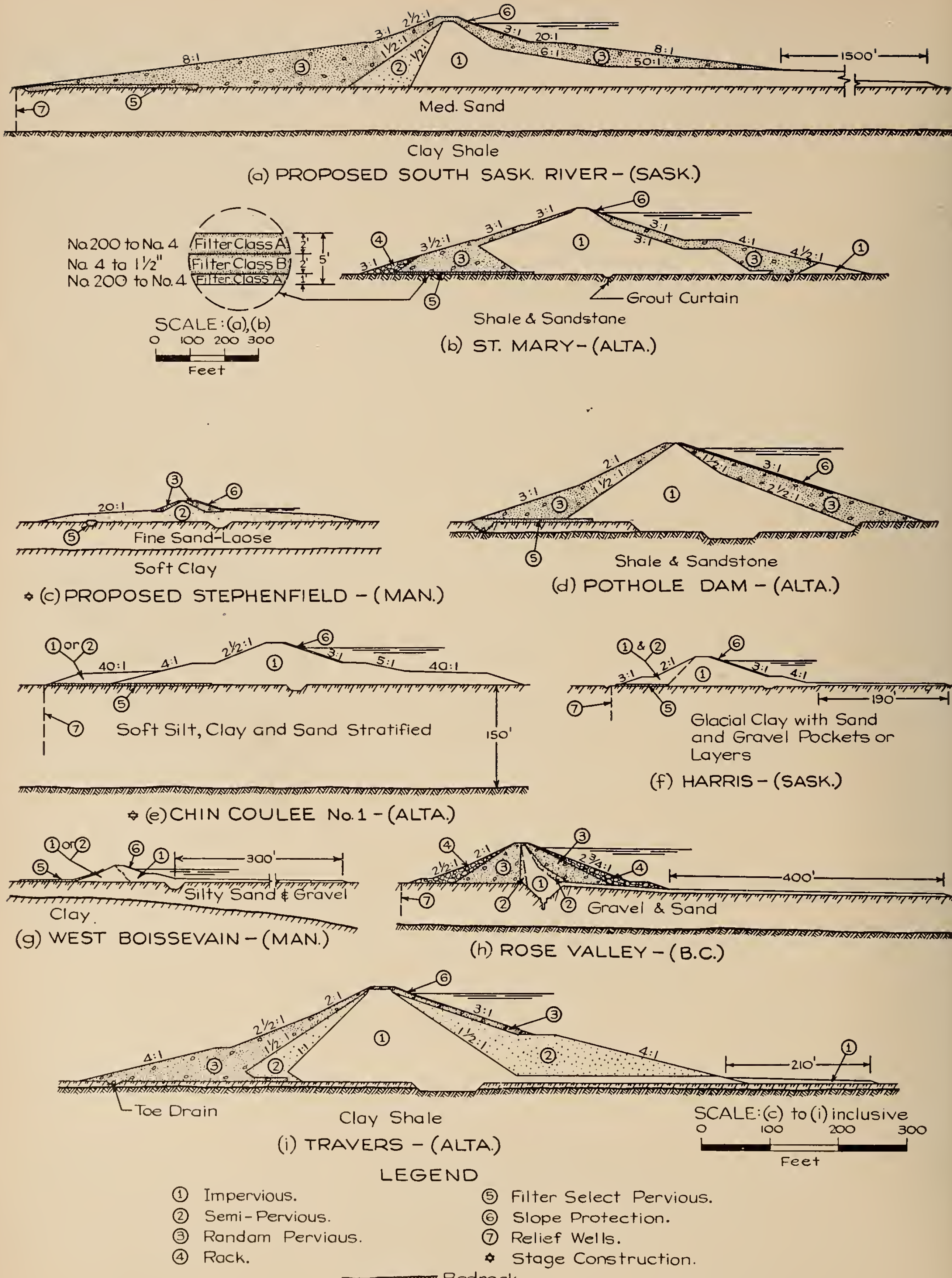


Fig. 9. Typical Prairie Farm Rehabilitation Administration dams — maximum section.

able reliance being placed upon observations during construction and operation.

Acknowledgments

The writer would like to express appreciation to G. L. MacKenzie, chief engineer, P.F.R.A., for permission to publish this paper and to G. N. Munro, assistant chief engineer, W. L. Foss, supervising construction engineer, St. Mary Irrigation Project, and N. L. Iverson, soil mechanics engineer, for reviewing the manuscript and making a number of helpful suggestions.

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Economic Fuelling of Nuclear Power Reactors

(Continued from page 127)

to the nuclear physicists. The problem remains to develop the commercial methods for achieving such densities on a production scale.

The second major problem is that the sheath must make good contact with the oxide fuel for good heat transfer. This too is at present under investigation. Preliminary experiments on prototype oxide fuel elements have been very encouraging.

In experiments, the sheath has been artifically ruptured with no apparent detrimental effect on the fuel under irradiation. Also, the oxide has shown a remarkable dimensional stability under reactor conditions.

We have confidence in this aproach to an economic power reactor fuel. This confidence is indicated by the recent decision to use uranium dioxide as the fuel for the forthcoming NPD reactor. NPD is the Nuclear Power Demonstration reactor being designed and built through the co-operative efforts of Atomic Energy of Canada Limited, the Ontario Hydro-Electric Power Commission, and the Canadian General Electric Company.

Summary

In summary, I would like to make the following points.

First, the economic fuelling of a power reactor which can compete with present day thermal power stations is possible.

Second, the choice of the heavy-water reactor offers the most attractive promise for achieving low fuel costs.

Third, work at Chalk River encourages the belief that the practical limitation on achieving economic fuelling costs can be overcome, probably in the near future.

Finally, there is no doubt in the minds of those who are working in the field that nuclear power is here to stay. The most authoritative prediction I can give you is that of our president, W. J. Bennett, in a statement made before the parliamentary committee on research on 5 June 1956—

> ". . . nuclear energy will play a quite modest part in supplying power demands up until 1971. During the 1970's, it is probable that several million kilowatts of nuclear capacity will be installed. By 1981, nuclear power plants may conceivably account for as much as 10 - 15% of the total generating capacity in this country and beyond that period this percentage will increase . . ."

There is a good deal of work to be done to make this prediction come true. It will require the best efforts of both research establishments and Canadian industry. However, the need is there and the vision is strong. I have no doubt that it can be achieved.

Management's New Tool —

Automatic Computers

W. Smuck,
International Business Machines Company Limited

Read at a meeting of The Engineering Institute of Canada, Montreal Branch, Management Section, November, 1956.

THE TERM "automation," fundamentally applicable to a process in which machines operate other machines, has been associated in recent years with mechanized production line operations.

With the introduction of electronic data processing machines, many have associated a parallel revolutionary development in office procedures; however a review of the growth of large electronic computers will show that they are just another step in the evolution of the ultimate — the "automatic office."

For many years, man was restricted to the use of his fingers for counting purposes. The introduction of the "abacus," however, gave him a more practical device for performing arithmetic operations. In 1642, Pascal introduced the principle of the "toothed" wheel in an adding mechanism — a device to add one with a turn of one notch; this concept, with modification, has been utilized in the functions of present day adding and calculating machines. During the 1830's, Charles Babbage attempted, without success, to develop a calculating machine with automatic sequence controls; i.e., to perform a number of operations in sequence and automatically.

Although these ideas have shown a significant influence on the development of computing devices we should recognize that a concept, introduced by Dr. Herman Hollerith in 1887, has dictated the trend in the mechanization towards the automated office. The idea was to record data into a card as a combination of holes in preassigned locations and to engineer machines to process these cards, subject to the information contained therein. This was the basis for research in the past half century by many business equipment organizations.

Let us at this time review briefly the basic accounting machine equipment, utilizing the punched card.

The basic record for the equipment is a card (7⅜ in. by 3¼ in.) which is capable of storing permanently 80 characters of information (alphabetical or numerical) in the form of punched holes. Being so registered, a punched hole can function in many ways; such as:

(1) add itself to something else;
(2) multiply itself by something else;
(3) classify itself;
(4) file itself;
(5) list itself;

and others.

The initial registration and the above mentioned operations are mechanically controlled.

"Card punching" is the basic method of converting source data into the punched cards. This is followed by preparatory operations, such as arranging the cards in a specific sequence, adding additional cards, and selecting cards, which can be done automatically by different machines.

The "card sorter" is capable of grouping cards in sequence — numerical or alphabetical — according to any classification punched in them. Individual cards can be selected automatically either by the sorter or collator according to the type of selection; for example; all cards higher than a specific number; cards between two specific numbers; cards out of sequence, etc.

Merging is an automatic operation, performed in the collator, of combining two sets of punched cards, each in the same sequence, into one set of that sequence. Matching is the term applied to the function of checking the agreement between two sets of cards, by a comparing procedure on the collator.

These preliminary operations prepare the card records for processing through other machines.

Information, punched in the card, can be interpreted in report form by the use of an accounting machine. Other operations possible during printing are addition, subtraction, cross-addition, cross-subtraction, printing of totals and the automatic conversion into punched-hole form of information developed within the machine by attaching another unit.

For many years, business, finance and accounting organizations used these basic machines to produce various reports automatically. Increase in business since World War II accentuated the restrictions imposed by the type of arithmetic possible on the accounting machines.

The demand for machines to do

more complicated arithmetic resulted initially in the production of electromechanical calculators with limited automatic sequence control. With the harnessing of the electron for counting devices, a small digital electronic calculator was made available by the author's company for business and research. This electronic calculating punch can read and punch data at the rate of 100 cards per minute, and for each card up to 60 individual steps of arithmetic may be performed; for example add, subtract, multiply, divide, or logical tests such as "is a number negative?"

In a mechanical system, incorporating components of the type described, the punched card becomes a control link for data processing. Conventional punched card equipment has been and is used successfully in the processing of many business applications — payroll, sales accounting, cost accounting, inventory, customer billing, public utilities, and others; and in scientific computing—correlation and regression analysis, matrix problems.

The increase in record keeping, management's demands for more accurate and current reports, and the proposed mechanization of new applications were only a few of the factors that affected the engineering of machines with increased processing speeds, input-output media to balance the processing speeds, and additional memory storage. These are the electronic data processing machines.

Before the introduction of the machines for accounting and record-keeping applications, a computer with the features mentioned was designed primarily for engineering and research calculating.

Here is a brief review of the fundamentals of the electronic data processing machine, type 705.

Memory

The memory, although not as compact and efficient as the human brain, is capable of storing 40,000 characters of information, any one of which can be located and transferred in seventeen millionths of a second.

The storage device consists of magnetic cores; tiny doughnut-shaped objects that can "remember" information indefinitely.

The memory stores the input data to be processed, data to be recorded on some output device, tabular values, and the program (series of instructions) to be followed by the machine in the processing.

Control Unit

Associated with the memory is the control unit which tells the machine where to get data, what operations it is to perform and where to place the answer. The control unit functions in accordance with the sequence of operations contained in the program.

Arithmetic Unit

The arithmetic unit does the actual processing of data under the direction of the operation interpreter — the control unit. The 705 machine performs all the arithmetic in the decimal system and has the ability to perform comparisons. Calculating speeds: 504,000 additions or subtractions, 50,000 multiplications, 24,000 divisions, render 1,765,000 logical decisions in one minute.

The electronic data processing machine can prove to be an invaluable tool to management, according to the author, who outlines the operations of a typical instrument. Electronic machines are "only hardware" until man applies his creative thinking; their function is to relieve mental drudgery, not to subjugate it.

Operator's Console

The operator's console is both an operator's control of the machine by use of a keyboard and a machine's control of the operator by use of the typewriter.

Using the keyboard and console, the operator can enter data directly into the machine or control its operations. The information recorded on the typewriter by the machine is subject to the control of the program.

Input Devices

In addition to the keyboard on the console, information can be accepted from: (a) punched cards at the effective rate of 20,000 characters per minute; (b) magnetic tape at the rate of 15,000 characters per second.

Magnetic tape is a plastic film, ½-inch wide, with a thin layer of iron-oxide on one surface. Information is recorded in the form of magnetized spots at a density of 200 characters (alphabetic or numeric) per inch. One reel of tape, 2400 feet in length, can store permanently the equivalent of 25,000 distinct punched card records. Magnetic tapes can be processed thousands of times without signal deficiencies.

Output Device

In addition to the typewriter, which can print 900 characters per minute from memory, information can be recorded in the following ways:

(a) punched cards at the rate of 8,000 characters per minute.

(b) magnetic tape at the rate of 15,000 characters per second. The "write" operation on tape has a dual function — that of erasing (demagnetizing) the previously stored data and of recording the new information from memory.

(c) Line-printers of various speeds: 18,000, 60,000, or 120,000 characters per minute which is the equivalent to 1,000 lines of 120 characters each.

The electronic data processing machine is a general purpose data processing system, with a multiplicity of input and output devices: card readers, magnetic tape units, card punches, line printers. The machine becomes an efficient special purpose machine by merely changing the program stored in the memory and connecting the appropriate input and output units. To retain a state of optimum operation, the processing of voluminous files should be directly from magnetic tape to magnetic tape. Conversion of punched cards to magnetic tape, or magnetic tape to printed documents or punched cards, is an ancillary operation; i.e., independent of the memory.

In the preceding paragraphs is described a large electronic data processing machine capable of processing from basic data to final results subject to a predetermined series of operations in a short period of time without the intervention of an operator — a major advance towards the automated office.

With mechanisms of this calibre or of smaller classification, such as the IBM Type 650 magnetic drum data processing machine, the concept of integrated data processing has become a reality.

The underlying theme in the concept of integration or automation is "one-time recording" of source data. This is accomplished by the development of machines such as "typewriter card punch" — the automatic punching of a card at the time of typing a document; "typewriter tape punch" — the automatic punching of a paper tape, to be converted to cards by a subsequent operation while typing a document; "transceivers" — the automatic and direct transmission over telephone or telegraph circuits of punched card information.

Further review of machine advancements would only emphasize the fact that electronic machines are here to stay, and that we must recognize their potentiality in Canadian business for applications such as production control, perpetual inventory, insurance, billing and sales, railway revenue, and others.

The natural question that may arise in everyone's mind at this time is "won't this do away with many jobs?" It is conceivable that these machines would directly influence the type of jobs; i.e., replace tedious routine jobs by positions requiring the ingenuity of the human brain.

Thos. J. Watson, one of the great pioneers in the office equipment field, has this to say: "Automation will develop as all other forms of power have developed. Primitive man had only his hands, then animal power, then wind power, then came steam, and electric power, then gasoline and oil power and now atomic power. Man power became more valuable than ever. Never in history has man received higher rates of pay for his work than he is getting today."

Comments such as "automation and mechanization in offices will cause mass unemployment" become meaningless when we note that, in Canada, the relative increment in the clerical force since 1900 has been over 800 per cent, despite the fact that the rise of business equipment has increased each year. Another significant factor is that in 1900, the clerical classification represented only 3 per cent of the total labour force in comparison to the 10 per cent ratio existing at present.

Theoretical mathematics has played a major part in the solution of major business problems, such as, "to determine the location of distributing warehouses in order to minimize shipping costs and to make the products available to the market in those areas" or "the correlation of past experience with present conditions for anticipation of the future." Problems of this type are categorized under the new field of "operations research."

To date, solution of such problems was a manual trial and error procedure. In the future, the results will be computed automatically and accurately by using electronic data processing machines.

The concept of integrated data processing is a challenge to management and it will have a profound effect on the way in which we will operate in the future. The trend in labour will be a reduction in unskilled personnel, but a demand for highly trained staff to develop the procedures for and to process the information from the electronic data processing machines.

The function of these machines is such that office operations will be unified and centralized under direct management control; it is no longer a departmental operation. The "logical" ability allows these machines to make decisions, subject to a predetermined program and limits, on volumes of records and to isolate only the records, not in agreement with all the restrictions. In this way, it is possible to process all records, but only report the items requiring immediate action. Such an approach is "management by exception."

Now is the time for management to consider electronic data processing systems. The preliminary studies and implementation of such a system is a major program and may require a period of several months. Although automation in your office may appear more as a fantasy than a reality, failure to assess the merits of an integrated system or to capitalize on the information available at this time can jeopardize the status of the company in the future.

Since the system affects the overall organization and crosses departmental lines, it is essential that the program be controlled at management level.

Electronic systems have found the punched card the most economical and suitable medium for entering basic data. With this in mind, utilization of punched card procedures should be expanded before implementation of the new system. It is also essential that existing routines be itemized in a "procedure outline" with the idea of streamlining these operations by revised clerical operations or punched card mechanization; such a procedure may show considerable savings.

I think that we can all be very enthusiastic about these machines and what can and will be done with them. Electronic machines are not "brains," but only hardware, which remains lifeless until man induces some of his creative thinking to the "memory." These mechanisms are really slaves to the human race, with the sole function to relieve mental drudgery not to subjugate it.

Future Annual Meetings

1957

Banff Springs Hotel, June 12, 13, 14

1958

Quebec, Chateau Frontenac, May 21, 22, 23

1959

Toronto, Royal York Hotel, June 8, 9, 10

Engineering Properties v. Composition in Simple Binary Alloys

L. M. Elijah
Metallurgical Engineer, Ford Motor Company of Canada

D. J. Mack
Department of Mining and Metallurgical Engineering, University of Wisconsin, Madison, Wis.

Investigations were made to show qualitatively how engineering properties vary with gross composition in mechanical mixture alloy systems. Results obtained are discussed in this paper.

IT IS A WIDELY accepted fact that the engineering properties of metallic materials are structure sensitive. That is, as we vary the structure of an alloy, either by heat treatment, mechanical working or a change in composition we expect that the hardness, ductility, electrical resistance, and other properties of the alloy will exhibit (in most cases) a corresponding change. The changes in properties attendant upon microstructural changes induced by heat treatment and/or mechanical working have been thoroughly investigated quantitatively for all types of alloy systems. This is not true, however, for changes in these properties caused only by gross variations in composition of the alloy, as for example, entirely across a simple eutectic alloy system.

These relationships of gross composition *v.* the engineering properties are well documented for steel, cast iron, and single-phase solid solutions. For other materials, principally alloys whose structure is of the mechanical mixture type, there is almost no information available in the literature. What experimental data exist are seemingly contradictory. This is not surprising if one considers the complex of factors determining, say, the ultimate tensile strength of a mechanical mixture type alloy. Within this complex there would be such contributing factors as: the flow and fracture characteristics of each phase and how these affect each other; the mean free path over which each could operate; the size, topology and overall distribution of the metallographic phases; the cohesion between phases, etc., not to mention the common metallurgical variables such as: amount and kind of working, segregation, and others. Attempts have been made, based largely upon analogy and empirical reasoning, to predict qualitatively the relationship between composition and properties in such systems. The more reasonable attempts have been made by Johnson[1] and Harrington[2]. Examples can also be found in most textbooks on physical metallurgy. Because of this lack of quantitative information, it was decided to measure the common engineering properties as functions of composition in several different mechanical mixture type alloy systems.

Experimental Procedure

Five different simple binary alloy systems were finally selected for study, the selection being based on the consideration that all the component metals were cheap and readily available in a high state of purity (to avoid extraneous solid solution effects), and that they all melted at fairly low temperatures, thus facilitating melting and casting. Since these alloys were all to be of the mixture type it was realized that segregation during freezing would be a serious problem. Accordingly, all alloys were centrifugally chill cast as one-inch bars, four bars of each analysis being cast in a cluster. Three of the bars were used for property determinations, the fourth being held as a reference bar. The procedure followed was that each bar was machined to a ¾ x 6 inch cylinder and its electrical resistance determined, after which it was machined to a standard 0.505 inch test bar with threaded ends, and its tensile properties determined.

Despite all precautions and numerous attempts, it was found impossible to prepare sound test bars of the complete range of compositions in the monotectic Cu-Pb and Zn-Pb systems. The Cu-Pb system was abandoned but a series from the Zn-Pb system was ultimately prepared. Finish machining revealed that they were sufficiently unsound, however, to use for mechanical property determination and so only electrical resistance was measured. Because of the brittleness of the Sb-rich alloys, the Pb-Sb alloys were prepared only up to 25 per cent Sb.

The results are shown by means of graphs, the composition being plotted against the various properties. In each case, the phase diagram is also shown for reference.

The Al-Sn system. The eutectic in

*Extracted from a thesis presented by Leo M. Elijah to the Graduate Faculty at the University of Wisconsin in partial fulfilment of the requirements for the degree of Master of Science, Metallurgical Engineering.

this system (Fig. 1) occurs so close to the Sn axis that its effect on the microstructure and properties as determined here seems negligible as do the very slight terminal solid solubilities at both ends. Accordingly, all alloys can be regarded essentially as a mixture of aluminum and tin, the tin in all cases being the continuous phase in the structure. On this basis the properties should obey the rule of mixtures and be linear functions of composition. Only the electrical resistivity and hardness conform to the prediction. Elongation and reduction in area are curvilinear and both show minima, suggesting that because of the difference in properties of the aluminum and tin the topology of the microstructure is important. The tensile strength curve is linear down to about 20 per cent aluminum, after which it drops in a smooth curve to the value for pure tin. This also indicates a critical distribution of the micro-constituents. Although the analogy is far-fetched and probably illogical, a study of the flow characteristics of alloys in the region of this break point might be of interest in boundary microflow mechanisms.

The Zn-Pb system. As previously stated, due to the difficulties of casting sound specimens only the electrical resistivity of alloys in this system was measured. The results are shown in Fig. 2 and are as one would anticipate, the electrical conductivity being a linear function of composition.

The Sn-Pb system. The system, as shown in Fig. 3, consists of a eutectic with terminal solid solutions at both ends. It is somewhat unusual because, despite the extensive solid solubility decreasing markedly with temperature at each end, almost no age-hardening effects occur. This is fortuitous for property determination because variations in cooling rates or storage time amongst the various alloys become unimportant and it also means that probably no significant strain ageing effects will occur.

The properties are also shown in Fig. 3. The strong effect of solid solution formation on properties is well illustrated at both ends of the diagram. The ductility as measured by elongation and reduction in area is a minimum at the eutectic composition. Paradoxically, the hardness is also near a minimum at the eutectic composition and the tensile strength seems nearly unaffected by the relative amount of the finely divided eutectic structure present. The reason for this behaviour is known. The electrical conductivity behaves normally in that it is a linear function of the relative amounts of the two solid solutions present.

The Pb-Sb system. The effect of Sb in inducing age hardening in Pb is well known as is the fact that rapidly cooled alloys age at room temperature. Accordingly, all alloys were thoroughly aged before property determination, thus ensuring that the effect of the gross composition (microstructure) would be

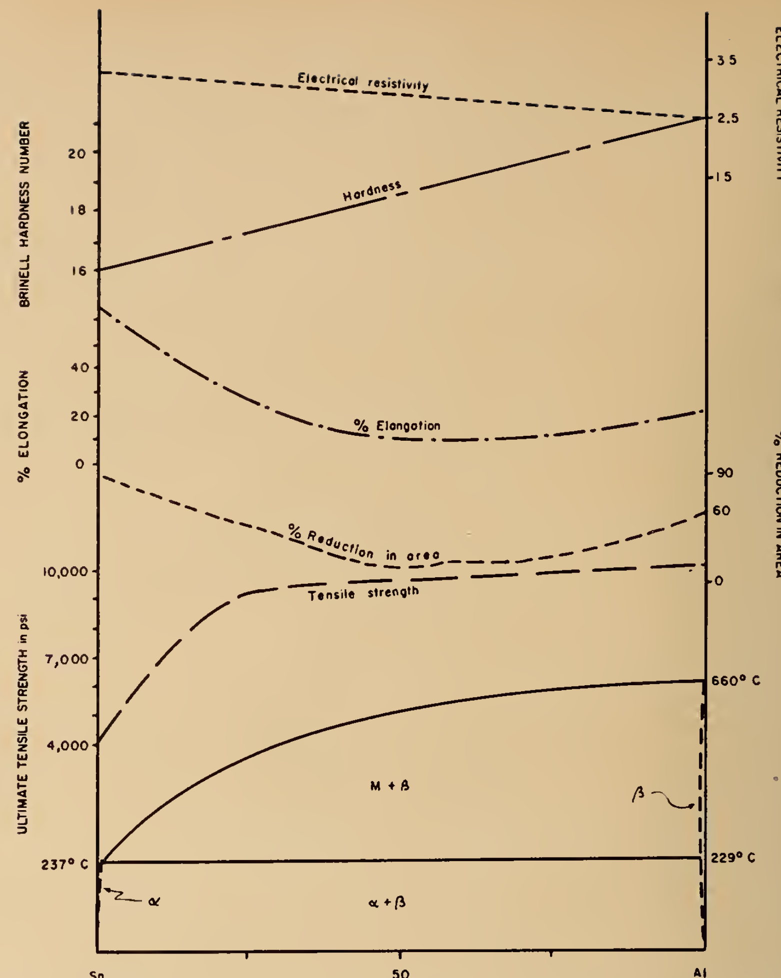

Fig. 1 Properties as a function of composition in the aluminum-tin system.

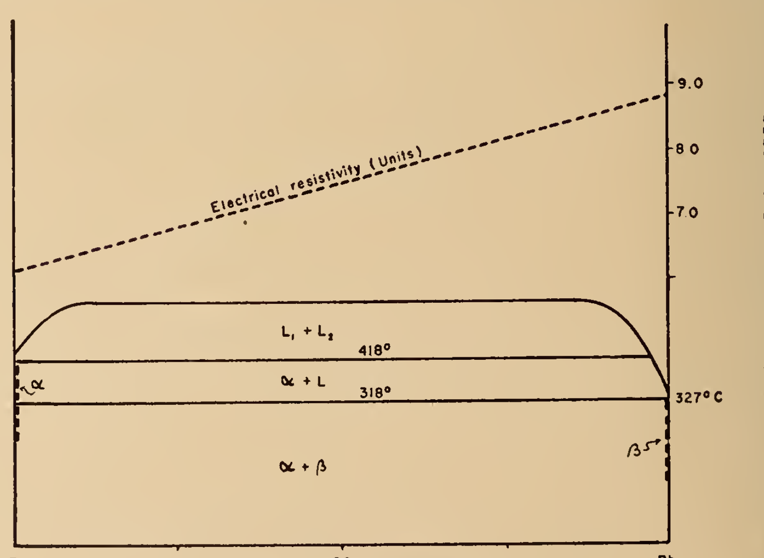

Fig. 2. The zinc-lead system.

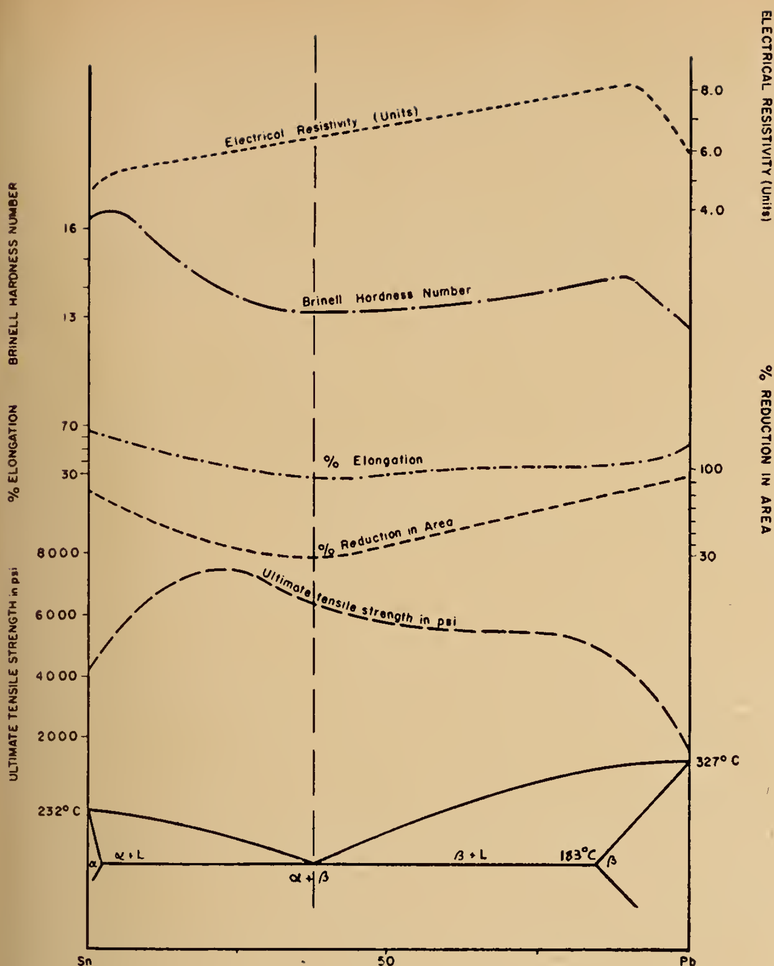

Fig. 3. The tin-lead system.

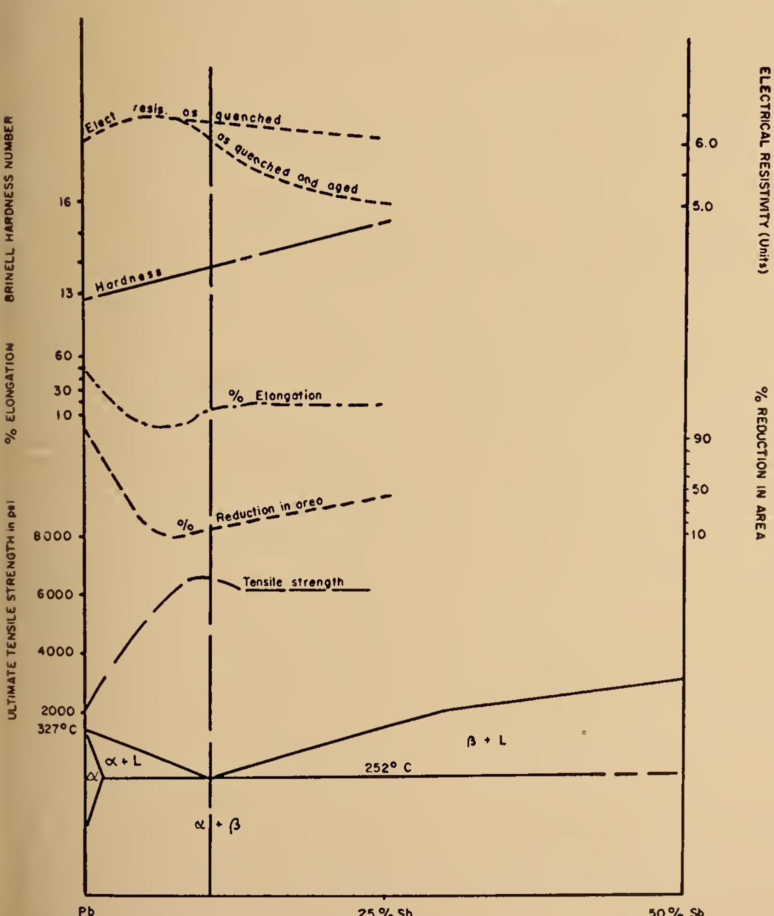

Fig. 4 (Below)
The lead-antimony system.

measured as unaffected by transitory ageing phenomena. The results are shown in Fig. 4.

Two curves are shown for electrical conductivity which illustrate how necessary it is in this system to control ageing if reproducible properties are desired. The resistivity is shown to be higher in the freshly quenched state than in the overaged condition, which is normal behaviour. That the two curves get farther apart with increasing Sb content is probably due to the fact that the Sb-rich phase which is present in increasing amounts is more affected by ageing than is the Pb-rich phase.

In general, the properties behave as one might expect. The elongation and reduction in area both show minima near the eutectic but on the lead-rich side, whereas the tensile strength maximum is at the eutectic composition. Why the minima in ductility and the maximum in tensile strength do not coincide is uncertain, but may be associated with some slight irregularities in ageing. The bumps shown on some published tensile strength curves in the region of 4-5 per cent lead are believed due to a lack of appreciation of the extent to which Pb-Sb alloys of this composition will age- and strain-harden.

The hardness curve which is linear is interesting because it serves to emphasize the danger of trying to correlate hardness with other properties in systems where the correlation has not been extensively studied.

Conclusions

These very brief results show that the attempts which have been made to picture qualitatively how the engineering properties vary with gross composition in a mechanical mixture alloy system have been moderately successful. They also show that the nature of the phases is more important than their gross amount or distribution in the microstructure of an alloy and that any attempt to picture the property curves as breaking sharply at phase field boundaries or at eutectic compositions is unwarranted.

References

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(2) R. H. Harrington, "Modern Metallurgy of Alloys", John Wiley, Inc., 1948.

Symposium on the

Transatlantic Telephone Cable

A meeting of the Institution of Electrical Engineers, the American Institute of Electrical Engineers, and the Engineering Institute of Canada, held simultaneously in London, New York, and Montreal, on 24 January, 1957, using the first transatlantic telephone cable.

THE TRANSATLANTIC telephone cable service was officially inaugurated on 25 September 1956 at simultaneous ceremonies in London, New York, and Ottawa (reported in the November issue of *The Engineering Journal).*

On 24 January, 1957, the cable links between Britain and the North American continent were once again used to enable a simultaneous meeting to be held in London, New York, and Montreal between the engineers and executives associated with the project, under the auspices of the Institution of Electrical Engineers, the American Institute of Electrical Engineers, and the Engineering Institute of Canada.

Greetings were exchanged between M. S. Coover, president, A.I.E.E., V. A. McKillop, president, E.I.C., and Sir Gordon Radley, president, I.E.E., who acted as chairman of the joint meeting.

The carefully organized and strictly timed program continued with the introduction of the authors from the three countries who had prepared papers on various technical aspects of the cable project. The authors spoke briefly of the work.

As a demonstration of the excellent quality of reproduction made possible by the cable, there followed an interlude of high-fidelity recorded music which amply demonstrated the great advance in quality that had been achieved.

Speakers in the three cities then had an opportunity of discussing the subjects of the technical papers before the meeting closed with remarks from particular sections of the three engineering organizations and from their respective presidents.

The Canadian group met in the auditorium of the Bell Telephone Company of Canada, in Montreal. Among the distinguished participants were T. W. Eadie, president, the Bell Telephone Company of Canada, and D. F. Bowie, president and general manager, Canadian Overseas Telecommunication Corporation.

Background to the Cable

An agreement covering the provision of a submarine cable system for transatlantic telephone service between the United States and Canada, on the West, and the United Kingdom, on the East, was made on 2 November 1953, between the principals concerned. These were: the British Postmaster-General; the American Telephone and Telegraph Company, New York (A.T. & T.); Canadian Overseas Telecommunication Corporation, Montreal (C.O.T.C.); and Eastern Telephone and Telegraph Company, Halifax, N.S. (of which the outstanding capital stock is owned by A.T. & T.). The agreement defines the share of the principals in the construction, maintenance, and operation of the service. Work started on the east-bound cable on 28 June 1955, and laying of some 2100 nautical miles was completed in three stages by September 1955. The corresponding west-bound cable was laid in three stages between June and August, 1956. During this time, other facilities were also completed.

Symposium Papers

The titles of the papers prepared for this symposium, and their authors, are listed below. Copies of the papers may be obtained from the Institute library, and some may subsequently be published in full. (Numbers in parentheses identify preprints of the papers issued by the Institution of Electrical Engineers.

A Foreword to the Symposium

Mervin J. Kelly,

President, Bell Telephone Laboratories, Inc.

Sir Gordon Radley,

President, The Institution of Electrical Engineers

A SERIES of technical papers will describe the design, manufacture and installation of the first transatlantic telephone cable system in all its component parts, including the connecting microwave radio-relay system in Nova Scotia. The purpose of this introduction is to set the scene in which this project was undertaken and to discuss the technical contribution it has made to the development of world communications.

Electrical communication between the two sides of the North Atlantic started in 1866. In that year the laying of a telegraph cable between the British Isles and Newfoundland was successfully completed. Three previous attempts to establish transatlantic telegraph communication by submarine cable had failed. These failures are to-day seen to be the result of insufficient appreciation of the relation between the mechanical design of the cable and the stresses to which it is subjected as it is laid in the deep waters of the Atlantic. The making and laying of deep-sea cables was a new art, and designers had few experiments to guide them.

During the succeeding ninety years, submarine telegraph communication cables have been laid all over the world. Cable design has evolved from the simple structure of the first transatlantic telegraph cable — a stranded copper conductor, insulated with gutta-percha and finished off with servings of jute yarn and soft armouring wires — to the relatively complex structure of the modern coaxial cable, strengthened by high-tensile-steel armouring for deep-sea operation. The coaxial structure of the conducting path is necessary for the transmission of the wide frequency bandwidth required for many telephone channels of communication. The optimum mechanical design of the structure for this first transoceanic telephone cable has been determined by many experiments in the laboratory and at sea. As a result, the cable engineer is confident that the risk of damage is exceedingly small, even when the cable has to be laid and recovered under conditions which impose tensile load approaching the breaking strength of the structure.

The great difference between the transatlantic telephone cable and all earlier transoceanic telegraph cables is, however, the inclusion of submerged repeaters as an integral part of the cable at equally spaced intervals and the use of two separate cables in the long intercontinental section to provide a separate transmission path for each direction. The repeaters make possible a very large increase in the frequency bandwidth that can be transmitted. There are 51 of these submerged repeaters in each of the two cables connecting Clarenville in Newfoundland with Oban in Scotland. Each repeater provides 65 db. of amplification at 164kc./s., the highest transmitted frequency. The working frequency range of 144kc./s., will provide 35 telephone channels in each cable and one channel to be used for telegraph traffic between the United Kingdom and Canada. Each cable is a one-way traffic lane, all the 'go' channels being in one cable and all the 'return' channels in the other.

The design of the repeaters used in the North Atlantic is based on the use of electronic valves and other components, initially constructed or selected for reliability in service, supported by many years of research at Bell Telephone laboratories. Nevertheless, the use of so many repeaters in one cable at the bottom of the ocean has been a bold step forward, well beyond anything that has been attempted hitherto. There are some 300 valves and 6,000 other components in the submerged repeaters of the system. Many of the repeaters are at depths exceeding 2,000 fathoms (2¼ miles) and recovery of the cable and replacement of a faulty repeater might well be a protracted and expensive operation. This has provided the incentive for a design that provides a new order of reliability and long life.

On the North Atlantic section of the route, the repeater elements are housed in flexible containers that can pass around the normal cable-laying gear without requiring the ship to be stopped each time a repeater is laid. The advantages of this flexible housing have been apparent during the laying operations of 1955 and 1956. They have made it possible to continue laying cable and repeaters under weather conditions which would have made it extremely difficult to handle rigid repeater housings with the methods at present available.

Single Cable

A single connecting cable has been used across Cabot Strait between Newfoundland and Nova Scotia. The 16 repeaters in this section have been arranged electronically to give both-way amplification, and the single cable provides 'go' and 'return' channels for 60 circuits. 'Go' and 'return' channels are disposed in separate frequency bands. The design is based closely on that used by the British Post Office in the North Sea. Use of a single cable for both-way transmission has many attractions, including that of flexibility in providing repeatered cable systems, but no means has yet been perfected of laying as part of a continuous operation the rigid repeater housings that are required because of the additional circuit-elements. This is unimportant in relatively shallow water, but any operation that necessitates stopping the ship adds appreciably to the hazards of cable laying in very deep water.

The valves used in the repeaters between Newfoundland and Scotland are relatively inefficient judged by present-day standards. They have a mutual conductance of 1000 micromhos. Proven reliability, lower mechanical failure probability, and long life were the criteria that determined their choice. Valves of much higher performance with a mutual conductance of 6000 micromhos are used in the Newfoundland-Nova Scotia cable, and it is to be expected that long repeatered cable systems of the future will use valves of similar performance. This will increase the amplification and enable a wider frequency band to be transmitted, thus assisting provision of a greater number of circuits. If every advantage is to be taken of the higher-performance valves, it will be necessary to duplicate (or parallel) the amplifier elements of each repeater, in the manner described in a later paper, in order to assure adequately long trouble-free performance. This has the disadvantage of requiring the use of a larger repeater housing.

Large Capacity

During the three years that have elapsed since the announcement in December, 1953, by the American Telephone and Telegraph Company, the British Post Office, and the Canadian Overseas Telecommunication Corporation, of their intention to construct the first transatlantic telephone cable system, considerable progress has been made in the development and use of transistors. The low power drain and operating voltage required will make practicable a cable with many more submerged repeaters than at present. This will make possible a further widening of the transmission band, which could provide for more telephone circuits with accompanying decrease in cost per speech channel, or the widened band could be utilized for television transmission. Much work, however, is yet to be done to mature the transistor art to the level of that of the thermionic valve and thus ensure the constancy of characteristics and long trouble-free life that this transatlantic service demands.

The present transatlantic telephone cable whose technical properties are presented in the accompanying papers, however, gives promise of large reduction in costs of transoceanic communications on routes where the traffic justifies the provision of large-traffic-capacity repeatered cables. The thirty-six 4kc./s. channels, which each cable of the 2-way system provides, are the equivalent of at least 864 telegraph channels. A modern telegraph cable of the same length without repeaters would provide only one channel of the same speed. The first transatlantic telegraph cable operated at a much lower speed, and transmitted only three words per minute. The greater capacity of future cables will reduce still further the cost of each communication circuit provided in them. Such considerations point to the economic attractiveness, where traffic potentials justify it, of providing broad-band repeatered cables for all telephone, telegraph and teletype service across ocean barriers.

The new transatlantic telephone cable will supplement the service now provided by radio telephone between the European and North American continents. It will add greatly to the present traffic-handling capacity of this service. The first of these radio circuits was brought into operation between London and New York in 1927. As demands for service have grown, the number of circuits has been increased. We are, however, fast approaching a limit on further additions, as almost all possible frequency space has now been occupied. The submarine telephone cable has come, therefore, at an opportune time; further growth in traffic will not now be limited by traffic capacity.

Technical Development

Technical developments over the years by the British Post Office and Bell Telephone Laboratories have brought continuing improvement in the quality, continuity, and reliability of the radio circuits. The use of high-frequency transmission on a single sideband with suppressed carrier and steerable receiving aerial are typical of these developments. Even so, the route, because of its location on the earth's surface is particularly susceptible to ionospheric disturbances which produce quality deterioration and at times interrupt the service completely. The cable transmission will be free of all such quality and continuity limitations. In fact, service of the quality and reliability of the long-distance service in America and Western Europe will be possible. This quality and continuity improvement may well accelerate the growth in transatlantic traffic.

The British Post Office and Bell Telephone Laboratories are continuing vigorous programmes of research and development on submarine cable systems. Continuing technical advance can be anticipated. Broader transmission bands, lower-cost systems and greater assurance of continuous, reliable and high-quality services will surely follow.

The Engineering Technician

A panel discussion held as Session 1 of the joint Conference of the American Society of Mechanical Engineers and the Engineering Institute of Canada, University of Western Ontario, October 1956

Dr. L. S. Beattie

Superintendent of Secondary Education, Province of Ontario
Moderator of the Session.

Radical changes in production methods, combined with our industrial expansion, have created an acute demand for scientists, engineers, and technicians. Formerly, the technician received all of his training on the job. It has been claimed that modern industrial engineering has substituted "operations" for "jobs" and hence has eliminated the work processes by which the technicians were trained. Under these changing conditions, therefore, it may be necessary to give the potential technician a basic technical education before he enters employment, thus enabling him to progress more rapidly in his on-the-job training. Moreover, in today's industry there is a strong trend to transfer the less creative and the more routine work of the engineer to the engineering technician who has received in a technical institute or a junior college an education the content of which is briefer, more technical, and less theoretical than engineering curricula.

To discuss the problems related to the enginering technician and his training, the members of this panel have been chosen from the fields of industry and technical education in both the United States and Canada. Light and heavy industry is represented by Mr. Kimball C. Cummings, associate director of aero research, Minneapolis - Honeywell Co., Minneapolis, and Mr. Robert S. Eadie, vice - president and general manager, Eastern Division, Dominion Bridge Co., Montreal. These two speakers will deal with the following questions:

(1) How does industry define the engineering technician?

(2) In what ways does his work compare with or differ from that of the graduate engineer?

(3) What is an ideal ratio of engineers to technicians?

(4) To what extent is the technician being trained on the job?

(5) How can industry assist and cooperate with schools of technology?

The education of the engineering technician will be presented by Mr. Howard H. Kerr, principal, Ryerson Institute of Technology, Toronto, and Mr. Karl O. Werwath, president, Milwaukee School of Engineering, Milwaukee. These speakers will attempt to answer the following questions:

(1) What are the qualifications for an entrant to the course in enginering technology?

(2) What specialized courses are offered?

(3) What is the nature of their content and presentation?

(4) In what ways does the school gain the co-operation of industry?

(5) To what extent do the graduates meet the present demand for engineering technicians?

R. S. Eadie

Vice-President and General Manager, Eastern Division,
Dominion Bridge Company Limited, Montreal, Que.

To discuss this or any other subject intelligently, it is first necessary to be sure that all those interested place the same meaning on the words used in defining the particular matter under discussion. The definition for an engineering technician adopted by the Conference of Commonwealth Engineering Institutes is:

"An engineering technician is one who can apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering or in those techniques especially prescribed by professional engineers. The techniques employed demand acquired experience and knowledge of a particular branch of engineering combined with the ability to work out details of a task in the light of well-established practice."

This definition appears to be complete but, after discussing the subject with representatives of several industries, it appears to me that it does not enable one to pinpoint the jobs held by engineering technicians in Canadian industry, in which there seems to be a difference of opinion among engineers and management as to what an engineering technician is and what type of jobs he can handle. I will try to define what I think is meant by the term by discussing actual examples of those I believe are and are not technicians.

First, I would eliminate from the class of technician all skilled mechanics and tradesmen such as machinists, toolmakers, pattern makers, etc. This is not a slur on these occupations because many of these men are very highly skilled and, in some cases, may be promoted to other positions where they may, in my opinion, be properly classed as technicians. For example, a highly skilled tool maker may, with additional training and with the necessary natural ability, be advanced to the position of inspector or methods layout man where he would be properly classified as a technician. We, of course, also eliminate all graduate engineers, although some may occupy positions which could be filled by technicians, particularly in the years immediately following graduation when they are obtaining the necessary basic practical experience in industry, or later due to a lack in the individual which cannot be overcome by training.

Since I am most familiar with the heavy engineering industry, I am selecting from the employees in that type of industry the following classes of engineering technician.

Structural and Mechanical Draughtsmen — These men make layout drawings, assembly drawings and, finally, the detail drawings which completely describe the finished product to be turned out in the shop.

Estimators — Men with ability to read drawings and to take off quantities from them so that these estimates may be used as the basis for the estimate of labour required to produce the finished product. Some estimators' previous training may enable them to estimate the labour allowance necessary for fabrication.

X-ray Operators — Men trained to set up and take the necessary x-ray or gamma-ray pictures of welded or other fabricated units so as to show up defects. In some cases, their extensive experience may qualify them to interpret the x-ray film and prescribe the method of repair. They work under the direction of a qualified welding engineer.

Welding Supervisors — In our operations men who have had long and varied experience as welders are used to supervise and control welding operators. They are concerned solely with the methods and techniques employed and the qualitative results obtained. They have no control on discipline or production. They work under the direct supervision of the shop welding engineer.

Service Men — All producers of heavy machinery and equipment must maintain contact with their customers to observe the operation of their equipment in the field and report to the designing engineers and shop personnel any improvements which they consider should be made to operation or maintenance. This is a position that may be filled by a graduate engineer, but, in many cases, as good or better results can be obtained by the use of a man, trained either in the shop or office, who has the faculty of observing and recording troubles and is able to suggest ways of overcoming or improving defective design.

Time Study Men — Time study can, and properly should, be controlled by a graduate engineer but the actual work of gathering, recording, and compiling the information can be done by technicians trained in the particular methods to be used.

Methods Lay Out Men — In all engineering shops, whether of the production or job type, the methods to be used in the manufacture of any piece must be pre-determined before the drawings are issued to the production shops. This work can usually best be done, again under the supervision of an engineer, by a man with shop training who has imagination and skill in the application of the machines and tools available in the shop.

Inspectors — In all engineering shops, some form of inspection must be maintained on the jobs as they progress and when they are finally completed. In jobbing shops this probably requires a man with a higher degree of skill than in production shops, as practically every job is unique and continuous reference must be made to the drawings.

During the panel session. From left: Karl O. Werwath; Dr. H. H. Kerr; Dr. L. S. Beattie, moderator; R. S. Eadie; and Kimball C. Cummings, addressing the session.

The foregoing examples may be sufficient to show the type of employee who, I think, should be classed as an "engineering technician".

It would appear essential, in all cases, that such employees should have a basic education equivalent to Junior Matriculation. This basic education may, of course, be obtained partially after leaving school by means of night classes or correspondence courses but, without it, a technician is not likely to go far. Of course, for the positions mentioned above there can be a difference in the emphasis on the subjects which are taken in this basic training.

Draughtsmen and Estimators

As draughtsmen and estimators form probably the largest group of the technicians referred to, I would like to discuss the possible methods of training these men.

A good draughtsman should have: (*a*) A thorough knowledge of arithmetic, geometry and trigonometry; (*b*) skill in the use of pencil, scale and tee-square; (*c*) preferably, some knowledge of descriptive geometry; and (*d*) knowledge of the detail standards and shop practice used in the particular plant or industry.

How are these men to receive the necessary training? There are at least three methods which may be followed.

If a boy has completed his matriculation course, including mathematics, he has acquired a good part of the knowledge required in item (a). With this background he can be taken into the drawing office where, in a special squad of trainees, he is taught the fundamentals of mechanical drawing and is introduced to the standards used in the industry. As his knowledge increases, he is gradually put on productive work.

If a boy has not completed matriculation, he can still be taken into the drawing office trainee squad and, if he is willing to make the effort, he can obtain the necessary basic training in mathematics which he lacks by correspondence course, night classes at technical or other schools, or by lectures given by the employer's staff. In some cases, instead of attending high school, boys enter technical schools operated in some of the provinces. These schools give a grounding in mathematics and some training in basic drawing and other basic skills. Depending on the school, some of the graduates can be quickly made into productive draughtsmen. In other cases, it may be necessary to give additional draughting instruction before trying to incorporate these people into the productive squad.

Staff Lectures

No matter by which line of approach a student draughtsman has come up, all new employees should receive some lectures given by the employer's staff to instruct them in the standards and practices which are peculiar to that industry or plant. Men that receive such a training are essential to industry and from the point of view of the individual there is good opportunity for promotion to positions which are rewarding both financially and as to responsibility.

Some draughtsmen with a special interest in mathematics may be further trained as estimators and as designers of simple structures. These men can take off quantities of material for estimating, make estimates of labour hours required, and do other such repetitive work. Some may also advance further and, by study, gain a very sound knowledge of machine and/or structural design. Such men, in many cases, are more useful to a manufacturer as a designer than a graduate engineer who has not too much practical experience.

We have, through the years, employed a large number of draughtsmen trained in the British apprentice system, which includes a very complete course in both shop and office. These men are very satisfactory and, in many cases, can do a considerable amount of design work, particularly if they have secured the National Higher Certificate issued in Britain.

In some cases, of course, a technician may proceed to take the necessary examinations and obtain registration as a professional engineer.

Training of the other types of technicians which I have mentioned, may be varied. It may be via technical school, tradesman's apprenticeship course, or by training in the special technique in the shop. In all cases, however, the trainee must have a basic knowledge equivalent to high school matriculation together with an ability and a desire to study and to apply himself.

With respect to the ideal ratio of engineers to technicians, I would certainly not hazard a guess for the heavy manufacturing industry.

As already stated, I think that a large part of a technician's specialized training must be done on the job. I think, however, that technical schools do serve a useful purpose and that industry should and can cooperate with them. As an example, I would suggest that the trips of teachers to plants, such as arranged by the Montreal Board of Trade every year, serve a very useful purpose in acquainting the teachers with what industry needs and expects from the graduates. Also, I think that further use could be made, in night schools especially, of instructors from industrial plants to cover the practical and some theoretical courses.

Kimball C. Cummings
Associate Director, Aero Research, Minneapolis-Honeywell Company, Minneapolis, Minn.

Considerable emphasis has been given to the shortage of engineers and the role of the engineering technician in partial relief of this shortage. Perhaps not so widely recognized is that the engineering technician has a rightful and not just a substitute place on the industrial engineering team. The effect of the engineering shortage has created a greater need for higher qualified men as technicians thereby amplifying the technician's role. Part of this panel will discuss what the technical institutes are doing to fulfill the demand for the higher quality product. This talk covers how American industry is utilizing technicians, what it is doing to upgrade the quality of its current technician staff, some ways schools can cooperate, and what is the outlook for technicians.

Definition of the Engineering Technician

One can find many definitions for technicians. Yet, none seem to be exact enough. The technician's job is really a continuum of jobs, each one overlapping several others. At one end of this spectrum of jobs lies the craftsman. The other extreme is represented by the engineering aide. In between lies a juxtaposition of skills and abilities creating a skein of jobs.

When we speak of the engineering technician, we'll have to assume that he works in an engineering department, and that he has some contact with an engineer who is the source of work for the technician. As an example, draughtsmen are sometimes not considered engineering technicians, although many companies classify them generally as such. Many draughtsmen, however, by outside and on-the-job training develop their ability to where they can be classified as engineering technicians in every sense of the meaning. The same is true of machinists and other craftsmen who are normally thought of as being in tradesman areas.

The American Society of Engineering Education defines* the engineering technician as one who engages in work that requires some of the knowledge and skills of both the professional engineer and the skilled craftsman. The type of industry, the job assignment, and the abilities of the person determine the composition of the job, and its real definition.

Bell Telephone Laboratories defines** three technical aide classifications. The lowest is the technical assistant, which requires technical institute or equivalent training. These work under close direction of more senior members, and in a supporting capacity. The second, the technical staff associate, requires greater experience on the job, demonstrated ability to carry on work of greater degree of complexity and with less supervision than is given the technical assistants, and sometimes more formal training. The third, senior technical associate, is a classification carrying sufficient responsibility and latitude for the exercise of independent judgment to make it qualify for exemption under the Fair Labour Standards Act. In general, it requires a formal preparation equivalent to a four year college course. It involves the ability to undertake work independently on a project basis.

It may not be necessary to make a limiting definition, since so much depends on the type of work and other factors. A clearer understanding of the engineering technician can be obtained by examining the types of work he does in industry. I cannot, of course, speak for all American industry, but will try to give you some examples.

General Motors, as described by Mr. DeMause in the *Wall Street Journal*, has a "balanced engineer-technician team." They use "service" departments which cut across broad areas such as engines, exhaust, fuels, and cooling. One service department may handle all testing, for example. Each department has many technicians, working group leaders, and junior engineers.

* The Engineering Technician, booklet available from Editor, **Technical Education News**, 330 West 42nd Street, New York 36, N.Y.
** "The Graduate Engineer—His Training and Utilization in Industry", S. B. Ingram, **Electrical Engineering**, 1956. vol. 75, no. 2, Feb. p. 167.

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One company, in constructing a large electrical generating station, uses technicians for directing construction and erecting operations, for inspecting material and finished work, and for installing machinery and electrical apparatus.

At Minneapolis-Honeywell we have pool-type operations such as model shop, draughting and technician shop. However, part of the men in the latter two groups are given team assignments which may last for a long time or sometimes for short periods. In addition to the pools, many technicians are employed directly on the engineering or research teams.

Examples of Work Assignments

It is difficult to give representative examples of the work performed by engineering technicians because of the broad spectrum I mentioned earlier. Perhaps I can pick out a few jobs within this spectrum and give some details on them. It is to be assumed that all of these jobs come under the direction of engineers or appropriate work directors.

Engineering craftsman engages primarily in manipulative skills in making a part or a device from a finished drawing, and uses freedom in the construction process to arrive at the final designated form. He may make suggestions to the engineer to change the design so that the fabrication may be easier.

Design technician engages primarily in manipulative skills, but works from rough sketches or verbal instructions and often supplies his own concepts as to the final form of the device.

Computist does calculations for the engineer. He may operate a desk calculator, slide rule, use charts, graphs, and tables for solving equations, draw graphs, reduce data, wire panels for computer operation, and other tasks which are essentially of a computational nature.

Test Technician assists engineer in environmental tests on components and complete systems; sets up equipment, runs tests, prepares data for report, and may even analyse data and write a test report on routine tests.

Design aide assists design engineers in his work. He expedites and coordinates building of duplicate engineering models, does design computational work, makes minor engineering studies, does routine design changes, assists in design data releases, parts lists, drawings, follows progress of equipment through service organizations and does repetitive engineering work once accomplished by the design engineer.

Research aide assists the research engineer in his experimental or analytical studies. He may perform research experiments, collate data, assist the engineer in setting up and solving problems on analogue or digital computers, program and code instructions for the computers and analyse and present results to the engineer. He may solve a complete problem of a repetitive nature by himself. During the computer solution the research aide assists the engineer in more of the repetitive operations. In many cases, he will be able to carry on the computer analysis alone, and where only a slight modification is required, he can probably carry on the whole analysis by himself.

Flight technician prepares equipment and instrumentation for flight test. He may design the necessary fixtures to fasten the equipment to the airplane, and arrange the instrumentation system to get the required data.

Technical writers write reports and instruction manuals from data supplied by engineers. One company relieves the engineer of all report writing, whereas others supply a technical editor.

Production technician helps prepare methods analysis, assists in design of production tooling and production control functions, assists in production operations and construction and maintenance of complex production equipment.

Levels of Responsibility

One of the problems apparent on the engineering team is the division of responsibility between the engineer and the technician. The engineer must develop the ability to assign work to the technician so that he is fully effective. Too much delegation can lead to possible compromises in the engineering design, whereas too little can create a clerk out of the technician. Training and coaching of both the engineer and technician is required to achieve harmony, and probably most of it has to be done on the job rather than in the academic classroom.

There is no sharp line of demarcation between the responsibility of the technician and the engineer. Some like to use the terms "how" and "why" to differentiate between the technician and the engineer. Any way of looking at this still depends on the particular situation and on the individuals concerned. I believe we should continue to increase the technical responsibilities of all groups, and encourage formal and informal training to make this possible.

Training Activities

On-the-Job Training

The simplest method is on-the-job training. This is the training where a man learns by doing and by making mistakes. One of the important factors then is assignment of jobs so that a man has to learn more if he is to put in good performance. This would seem to hold true for either engineers or technicians.

Some companies intensify on-the-job training by giving formal courses relating directly to the job. For example, our company recently obtained a large digital computer for research use. We knew that we would need coders, programmers and mathematicians with proper training to make effective use of the computer when it arrived. We sent people out to learn the operation of this style of computer, and they instituted an in-hours course to train the people who would be working with it. This formal training continued after the equipment arrived, and now is done informally as part of the job.

After-Hours Courses

The Minneapolis plants of Minneapolis-Honeywell are fortunate in being close to the University of Minnesota where many basic courses are available and the company does not have to engage in teaching courses normally found in a university. In fact, along with hundreds of other U.S. companies, we offer tuition aid to employees who wish to take formal training which would benefit them in their present or future work. The after-hours courses which are taught on company premises are free to the students and cover courses for technicians, engineers, and others.

Special Training Programs

Some companies offer full tuition and, in certain cases, time off with pay to attend school. An article in the September 7th issue of the *Wall Street Journal* cited some of the training programs offered by companies to increase the technical ability of their technicians. For example, International Business Machines conducted a concentrated twelve weeks training program for technicians who can now handle some tasks formerly done by professional engineers.

Thus the educational opportunities

are there and those who wish to accept greater responsibilities need only to ask and act.

Relations with Technology Schools

With the shortage of engineers and technicians, the question can be asked, "What can industry do to assist and cooperate with schools training technicians?" Unfortunately, I am not familiar with the practice of American industry, but I can say what we at Honeywell have done in this direction.

Our problem was that we wanted to hire more technicians, and the supply of the type of technicians we required was not available in Minneapolis.

The first step made was to get acquainted with the sources of supply. Personnel representatives visited technical institutes to make personal contacts and gain an understanding of the school and the type and quality of graduates. We also contacted the junior colleges in Minnesota to see how their educational facilities and technical courses could fulfil industry's needs. We found all the schools eager to help and the main problem was communication — both internal and external.

The various engineering and research departments were asked to establish their technician requirements. Their requirements and the demand for manpower, and even specific individual needs, were outlined to the schools.

In the case of the junior colleges, where the curricula were not so well established in the areas we wanted, we arranged further contact with the faculties. After our representatives had visited all the colleges, the college presidents were invited to visit Honeywell. After a panel discussion of how technicians are utilized, a plant tour was arranged. The outcome of these contacts and meetings were course changes designed to meet ours and other industrial needs.

We have also arranged summer work for faculty members so that they can get a better understanding of our operations.

Finally, we are arranging cooperative programs and scholarships for students.

The Future for the Technician

Ratio of Technicians to Engineers

We speak of the shortage of engineers; less well known is that there is a greater shortage of engineering technicians. The ratio of technicians to engineers varies considerably in industry. A recent survey† shows ratios from 0.20 in the chemical and allied fields to 3.18 in the fabricated metal products field. The average for the 363 industries was 0.73. However, the hiring practice of 1956 shows the ratio to be over 1.00, which indicates the demand is about the same for technicians as it is for engineers. This ratio is expected to increase because of the compounding effect created by utilizing technicians more effectively on the engineering team.

Demand for Technicians

I know of no source where the yearly demand for engineers can be accurately found, nor where the demand for engineering technicians can be found. Various sources lead me to believe that 50,000 engineers and an equal number of technicians approximate the current annual demand for these groups in the United States. Engineering graduates will number this year about 30,000, fulfilling about 60 per cent of the demand.

It is more difficult to determine the supply of engineering technicians. The survey* made by Leo F. Smith, dean of instruction for the Rochester Institute of Technology, shows 11,350 graduates of technology courses one year or more in length. To these must be added the technological graduates of the terminal courses in the junior colleges. I am not aware of any available data on the number of graduates from the junior colleges. Mr. Smith mentions old data in his book**, but was unable to give up-to-date figures. Even if their graduates equalled the Technical Institute graduates, the supply of technicians would barely satisfy half the present needs.

These figures assume an average ratio of one technician to one engineer. Minneapolis - Honeywell is increasing their ratio and many other companies are doing likewise. One can only conclude that the technician shortage is going to get worse, before it gets better.

Personal Goals

One important point has to do with the outlook from the personal point of view of the technician. This point is that artificial barriers should not be put in the way of a technician such that he cannot enter into an engineering position in industry. We have several men who have, by virtue of their demonstrated proficiency on the job (which required outside study and devotion to his work), entered the engineering ranks. Most of these people tend to be specialists and do not have the flexibility of an engineer when switching jobs, but they do perform work of engineering calibre. The fact that advancement beyond technician ranks is possible often serves as a powerful motivation.

Future Role

The future of the engineering technician is tied to these three conclusions:

(1) The complexity of our times is increasing and will continue to increase. This will require more engineers and technicians.

(2) The current scarcity of engineers has created new opportunities for lesser trained people, and with the compounding of the increased need for engineers, the need for technicians will continue to grow.

(3) Automation will raise the skill required of the laboring force; hence more training will be required.

Dr. H. H. Kerr

Principal, Ryerson Institute of Technology, Toronto.

In an address last January on the subject of education, Sir Anthony Eden said: "The prizes will not go to the countries with the largest population. Those with the best systems of education will win. Science and technical skill give a dozen men the power to do as much as thousands did fifty years ago. Our scientists are doing brilliant work. But if we are to make full use of what we are learning, we shall need many more scientists, engineers and technicians. I am determined that this shortage shall be made good."

The shortage of scientists, engineers, and technicians is just as great in Canada as in England; and here as in England industry and all levels of Government are endeavouring to find an acceptable solution. There are many causes for this dearth of engineering manpower but one important factor is that the ratio between engineers and other types of employees is rising. Fifty years ago this ratio in the manufacturing industries was 1 to 300. Because of the tremendous changes that have taken place in production methods, the

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† "Demand for Engineering Graduates", **Electrical Engineering**, 1956. Vol. 75, No. 10, October, pp. 886-889.

* Annual Survey of Technical Institutes for 1955-1956, **Technical Education News**, 1956, vol. XV, no. 4, September, pp. 16-17.

** The Technical Institute, L. F. Smith, L. Lipsett; McGraw-Hill Book Company, New York, 1956.

ratio is now 1 to 50. Here is a prime reason for the shortage of engineers and the requirements for engineering personnel at all levels is such that the ratio may go even higher.

Recent Recognition

Only during the past few years have the capabilities of the engineering technician or engineering assistant, as he is sometimes classified, become recognized. For the past fifty years, the engineering faculties attached to many of our universities have offered excellent courses on both the under-graduate and the graduate levels. We have also had various good schemes for the training of our skilled craftsmen but the education of the engineering technician has been neglected, probably because it was only recently that Canada evolved an industrial economy. Since its establishment in 1948, however, the Ryerson Institute of Technology with its impressive growth has helped to direct attention to the training of the engineering technician and his potential value to a company. Since that date, moreover, there has developed a great shortage of professional engineers, and employers generally have turned to this new source for assistance to fill their engineering needs.

In January 1956 at a meeting of the Engineers Joint Council General Assembly, held in New York City, the engineering technician received national recognition. One-quarter of the time of the meeting was devoted to a discussion of the topic "Extending engineering manpower by utilizing balanced teams of engineers and engineering technicians".

Dr. Eric A. Walker, now president of the Pennsylvania State University, who delivered the opening address, was not overly enthusiastic about proposals suggesting that the way to solve the engineering manpower problem was to build and staff more and larger engineering colleges. Only a comparatively small percentage of the secondary school population had the native ability to absorb an engineering education and there did not seem to be much hope of increasing that percentage.

The intelligence quotient is by no means the only yardstick for prognosticating a successful career. Such qualities as determination, integrity, personality, attitude, and motivation are all highly important, but the I.Q. does apparently give a good indication of the student's ability to do abstract reasoning, the type of thinking required in an engineering course, as well as in many other courses.

Surveys have indicated that candidates with an I.Q. of less than 120 should not under-estimate the possibility of failure if they decide to embark on a full engineering course. It is estimated that only 10 per cent of the male secondary school graduates in the United States (figures are not available for Canada) have an I.Q. rating of 120 or more. About one-third of this group do not wish to proceed to college as they plan to enter industry or business directly from high school. Others cannot finance a university course, leaving only about one-half of the original 10 per cent ready and willing to go on to a degree in one of the recognized professions. If standards are to be maintained, therefore, there is a limit to the expansion of engineering colleges.

The Technical Institute

The technical institute, on the other hand, offers different types of curricula designed to produce persons who will make good engineering assistants or who will occupy other positions on the same level in the production, installation, or maintenance fields. Candidates for admission should be practical-minded individuals, but since they will not be called upon to produce the intricate designs or to make decisions involving highly technical data, it is not necessary for them to take the advanced theoretical subjects, a knowledge of which is required of the engineer. The I.Q. entrance requirement, therefore, could be dropped to possibly 110. This figure is still well above the average. Indeed, it is often used as a guide by persons giving advice to prospective college students but it is necessarily high since a good engineering technician must possess a keen mind and the ability to perform competently the work required of him if he is to act successfully as an aide to a fully qualified engineer.

A second source of recruitment is from the pool of able students who for one reason or another do not wish to undertake a full engineering course. A third source is from industry itself. There are always a number of persons who are forced to leave school before graduating and seek employment. A few years later they may find themselves financially able to resume their education.

It would appear, therefore, that it should not present too much difficulty to recruit students for engineering technician curricula. Actually, there are a number of obstacles that only time and imaginative careful planning will remove. Over the years, the universities have, quite rightly, built up an enormous economic and social prestige. The average parents, if not the average student, are determined in their efforts to send their sons or daughters to the university with its beautiful campus and buildings and offering all that is usually associated with college life. They feel that such an experience is worth almost any sacrifice and they hesitate to encourage their children so to plan their lives that they will complete their formal education in a non-degree-granting institution lacking the prestige and amenities of a college.

If technical institutes are to develop and take their rightful place on the educational ladder, they must be given at least the same status as would be accorded a junior college. The salaries paid to the instructional staff must be sufficient to attract highly qualified teachers. The buildings must be attractive and commodious enough, for instruction cannot thrive in inadequate quarters. From the point of view of the taxpayer, the cost per student at an institute is a great deal less than that at a university, but it costs the student's parents just as much, aside from fees, to send a son or daughter to an institute as it does to a university. Hence the educational environment must be acceptable.

Proportion of Technicans

It must not be assumed that engineering technicians should be graduated by the tens of thousands. A reasonable ratio in the United States is estimated to be 1½ technicians for each engineer. In Canada, many of our factories are branches of industries whose home plants are across the border. Consequently, a good deal of engineering work which ordinarily would be done here is performed at the head office. There is a possibility, therefore, that the ratio in Canada could be increased to 2 to 1.

The Canadian universities graduated in 1956 about 1,800 engineers, which means that between 2,700 and 3,600 additional engineering technicians should have been prepared this year to take their places in Canadian industry. Actually, the number was less than 300, which surely emphasizes that in this country we have a very unbalanced ratio of engineers and engineering technicians.

Ryerson Institute

The Ryerson Institute of Technology is one of the few institutions in Canada that is staffed and equipped to provide suitable training for the prospective engineering technician. It is a provincially owned and operated institution and, while the instruction is on the junior college level, the courses are terminal in character. This means that they are not specificially designed to provide the necessary requirements for entrance to a university course, although each year a number of our graduates do seek admission to engineering colleges. On the other hand, very few students who do not make their year at the university enrol at Ryerson. This is unfortunate and it would appear to be a wastage of manpower.

The Ryerson engineering technician courses — electronic, electrical, chemical, mechanical, metallurgical, instrument, architectural, and aeronautical technology — are of three years' duration, and the minimum entrance requirement is the Ontario secondary school graduation diploma obtained at the end of Grade XII. The first six of these courses have been accredited for technical institute purposes by The Engineering Institute of Canada.

Our failure rate is high; 35 per cent of our first year either drop out or fail in their final examinations. In the second year, this figure is 15 per cent, and in the third year 5 per cent. We have endeavoured to establish and maintain good educational standards. That these standards are acceptable to industry may be judged from the fact that this year there were almost four job opportunities for each graduate.

We have tried to keep our courses as broad as possible in order to ensure that our students will have some concept and understanding of the world around them, and of the opinions and thoughts of the great men of the world, both past and present. Our students, therefore, receive instruction in English for three hours a week during the three years of their course. They also take such subjects as economics, related science and mathematics, industrial organization and management. We insist on neatness and tidiness in dress and manner, for we believe such things are important.

Although almost two-thirds of the total enrolment is in the engineering technician curricula, Ryerson offers courses on the same level in such non-engineering fields as the graphic arts, business, hotel administration, and the furniture industry. The number of courses listed in the day school calendar is 22 and the 1956-57 registration is 1,982 students. The evening school consists largely of upgrading courses for employed persons, and last year's enrolment was 4,200.

Advisory Committees

Ryerson maintains a close contact with the industrial and business world by means of advisory committees. These committees are composed of prominent individuals in various firms connected with the industries we serve. The members favour us with a constant examination of our technological curricula. They assist us in securing scholarships and equipment, in establishing standards of attainment, and in organizing new courses to meet the needs of the industry concerned. Acting as liaison officers between the Ryerson Institute and the business and industrial world, they endeavour to interpret the work of the Institute to industry and obtain support for it in a variety of ways. The number of scholarships and bursaries provided our students by various firms is a source of pride and satisfaction to us.

Ryerson is serving a wide field: 50 per cent of the total enrolment comes from Metropolitan Toronto, 45 per cent from centres in the province outside the boundaries of Metro, and 5 per cent from other provinces. Thus, in its own way, the Institute is endeavouring to meet the need for trained personnel on both a provincial and national basis.

The professional engineering organizations in England, such as the Institution of Mechanical Engineers, and the Institution of Electrical Engineers, in co-operation with the Ministry of Education, have developed a system whereby the bright ambitious student who could not afford a college education can progress by various means from the Ordinary National Certificate to the Higher National Certificate, and then on to professional status. The Association of Professional Engineers in the Province of Ontario has done an outstanding job of encouraging qualified individuals to write their professional engineer's examinations, but there is not a clear-cut road as is the case in England. It is sincerely hoped that in time such a system will develop here, perhaps in a modified form. Without such a system, the technical institute is handicapped, for there are always a number of bright, young graduates who would make good engineers if they were given an opportunity, and it would make a difference in the mental outlook of the engineering technician if he knew he could advance himself to the top of the ladder, provided he had the determination and ability.

Automation and increased industrialization will need more and more technical institute graduates whose thoroughly practical and theoretical training enables them to step into responsible positions in factories and laboratories. Proposals have frequently been made for the establishment of more such institutions in other sections of the country, for the health of our economy demands it. Perhaps the time has come, however, when alternative methods of financing technical institutes should be investigated. Industry, commerce, and all levels of government benefit from the product of these courses. It seems hardly just that the duty of financing both the capital and operating costs should be the sole responsibility of the provincial government.

Present Predicament

There are few people who do not recognize the problems for our country created by the shortage of engineering personnel. Satisfactory solutions will require careful planning and it is encouraging to note the steps that are being taken to rectify the situation. The present predicament was ably summarized by Dr. James R. Killian, president of the Massachusetts Institute of Technology, in a recent article:

"The nation's technological work requires a broad spectrum of abilities and skills ranging from the technician, who does not need a degree, to the creative scientist or engineer whose education has carried him through the Ph.D. or even post-doctoral study. Men are in short supply throughout the entire spectrum but our greatest current shortages are at the extremes. We need more technicians to back up the professional scientist and more technical institutes to train them. At the other end of the spectrum, we need more graduate education and more graduate study opportunities to make this possible."

Most people will agree that this statement of Dr. Killian's mirrors the situation in Canada.

Karl O. Werwath
President, Milwaukee School of Engineering, Milwaukee, Wis.

A. What educational and personal qualifications do we look for in an entrant to a course in engineering technology?

Referring to the scientific and engineering technician, a statement incorporating these qualifications was developed for use by the working group for technical supporting personnel for scientists and engineers of the National Committee for the Development of Scientists and Engineers, as follows:

"The scientific technician and the engineering technician, although not new to the American industrial scene, are currently being employed in increasing numbers and are being given increasing responsibility to help alleviate the growing demand for engineering and scientific products and services. When utilized by industry or government, the scientific or engineering technician is usually employed in (1) research, design or development; (2) production, operation, or control; (3) installation, maintenance or sales. When serving in the first of these functional categories (research, design or development), he usually acts as direct supporting personnel to an engineer or scientist. When employed in the second categories (production, operation or control) he usually follows a course prescribed by a scientist or engineer but may not work closely under his direction. When active in the third categories (installation, maintenance or sales) he is frequently performing a task that would otherwise have to be done by an engineer.

"In executing his function the scientific or engineering technician is required to use a high degree of rational thinking and employ post-secondary school mathematics and the principles of physical and natural science. He thereby assumes the more routine engineering functions necessary in the growing technologically-based economy. He must effectively communicate scientific or engineering ideas mathematically, graphically and linguistically."

Specifically, the 1953 report of the recognition committee of the Engineers' Council for Professional Development defines the engineering technician as follows:

"An engineering technician is one who can carry out in a responsible manner either proven techniques which are common knowledge among those who are technically expert in his branch of engineering, or those specially prescribed by professional engineers. Under general professional engineering direction, or following established engineering techniques, he shall be capable of carrying out duties which may comprise: working on design and development of engineering plant; draughtsmanship; the erecting and commissioning of engineering equipment or structures; estimating, inspecting and testing engineering equipment; use of surveying instruments; maintaining engineering machinery or engineering services and locating faults; operating, maintaining and repairing engineering plant; or activities connected with research and development, sales engineering and representation, servicing, and testing of materials and components, advising consumers; training and education.

In carrying out many of these duties, the competent supervision of the work of skilled craftsmen will be necessary. The techniques employed demand acquired experience and knowledge of a particular branch of engineering, combined with the ability to work out the details of a job in the light of well-established practice.

"An engineering technician, therefore, requires a background sufficient to enable him to understand the reasons and purposes of the operations for which he is responsible."

While the engineer plans, the technician makes and does: while the engineer creates, the technician applies. This engineering technician is often the liaison between the professional man and the craftsman. He has the same basic characteristics and fundamental educational requirements as the engineer, except that his interest and education are more in the direction of application, with less mathematical and theoretical depth, combined with the ability to understand the instructions of the professional engineer and translate these to action either by applying his own abilities or in the direction of other supporting technicians and craftsmen.

B. What are the specialized fields of technology in which courses are offered?

There are some 100 courses accredited by the Engineers' Council for Professional Development or approved by the National Council of Technical Schools in ten fields in which engineering technicians have become prominent and in which technician employment opportunities have demanded course development. These fields include aeronautical design, maintenance and production; air conditioning, heating and refrigeration; architecture and building construction, civil technology; electronics and radio-television; electrical power and control; instrumentation and watchmaking; metal fabrication and tool design; photographic; and steam, diesel and automotive technology. In addition, there are some seven other miscellaneous highly specialized fields listed in the 1956 College Blue Book, such as gas fuel technology, fire protection, industrial technology, stationary engineering, surveying technology, chemical technology, and welding technology.

C. What is the nature of the content and presentation of those courses?

This type of instruction is in the broad area of technical education and lies between professional engineering on one side and vocational education on the other and is conducted by several types of institutions. Curricula are offered by one or more schools in the following categories:

Technical institutes, endowed or publicly supported.

Junior colleges offering terminal programs.

Evening sessions and extension divisions of colleges and universities.

Proprietary schools, operated by individuals or corporations.

Schools or training divisions associated with industries.

Specialized schools operated by divisions of government.

Correspondence schools.

Courses are from one to three years in length but generally require two academic years of full-time study. High school graduation or equivalent is required for admission and most courses have specific additional academic matriculation stipulations. These programs are briefer and more technical in content than are professional engineering curricula. They include a heavy schedule of specialized technical subjects which make up approximately one-half of the curriculum in class time and total company effort. These are integrated with and balanced by related studies in mathematics, physical sciences, graphics, English, economics, industrial commerce and general studies. Such courses now generally lead to an associate degree in engineering or applied science.

This is a specific type of higher education leading to specific occupations. Transfers from technical institute to other curricula or from one technical institute curriculum to another are relatively few. Credits are generally transferable for comparable subject matter.

D. In what ways does the school gain the co-operation of industry?

Relations with industry vary with each individual school, but in general there are some ten areas of co-operation which exist to a greater or lesser degree depending upon the individual organization.

(1) Where such schools are privately endowed, there is industrial leadership represented in the corporation membership and on the boards of control. Proprietary schools are generally owned by technical specialists who are consulting professional people and who have a close relationship with the industry which they serve. Thus, basic policy is conceived and controlled in an influence conducive to good relations with industry.

(2) Courses and subjects in publicly supported, privately endowed, or proprietary schools, are generally reviewed by industrial advisory committees. In some instances this takes the form of a formal board of visitors; in others, informal committees of laymen from industry, and professional and technical societies who are invited to review particular programs.

(3) Most schools have some form of applied industrial research conducted in conjunction with industry, especially in applied technical phases of research.

(4) Instructors, particularly those engaged in presenting the technical specialty subjects, are selected with consideration for practical industrial experience as well as academic training and teaching experience. In some instances, industry supplies teachers either for regular classes or for evening and extension classes, on a volunteer or a payroll basis.

(5) Industry supplies instruction aids, particularly laboratory equipment and apparatus for specialized laboratory experience. These are either donated outright or made available on a loan or grant basis, with opportunities for replacement for obsolescence or depletion. Visual instruction aids which implement classroom presentations, particularly films and equipment models, are also supplied by industry.

(6) Programs of part-time employment, either on a formal or informal basis, are quite general. Such programs often provide the additional revenue which makes it possible for students to complete day school courses. Late afternoon and evening courses lead to the same certificates or degrees in most metropolitan areas and fit into the plans of those who are employed full-time.

(7) Full-time placement service is maintained by the staffs of most technical institutes to aid graduates in finding appropriate first jobs in the field of their specialized training.

(8) Guest lecturers from industry augment the regular faculty, generally in highly specialized technical courses, and particularly for presentation of new developments.

(9) Field trips become an important part of a technical institute curriculum to convey specific information on scientific and industrial operations; they are preceded by pre-visit orientation and followed by formal or informal students' reports on such visits.

(10) Aid of members of professional societies and trade organizations, particularly through student branches of technical societies, alumni relations and participation in trade show and similar events, flow back into the school as a continuous source of ideas for integration into the program.

E. To what extent do your graduates meet the present demand for technicians?

There are various estimates as to the needs of engineering technicians in proportion to engineers; these range from 1 to 1 and 5 to 1, depending upon the industry and the area encompassed in the analysis. On the strong side, our best analysis shows the need for 35,000 four-year engineering graduates per year. This is about 200 per million population and parallels closely the existing ratios of other modern industrial nations of the world today.

If the ratio of technicians to engineers is 5 to 1, this would call for an annual production of some 160,000 technicians per year. In contrast, we graduated last year some 11,350 from courses in 66 schools. To meet the need, technicians have been developed through other sources, including evening programs and on-the-job training.

That there is a shortage in the nation's requirements is emphasized by the following report of the National Committee for the Development of Scientists and Engineers.

"A. The fact that there is a shortage of scientists and engineers, and that the ratio of technical to the whole labor force is rising, indicates a continuing and probably a growing demand for the skills of scientific and engineering technicians.

"B. The Department of Labor currently lists a number of these technical skills on the "critical occupations list".

"C. The experience of the working group indicates that competent graduates of engineering technician schools receive many offers of jobs and that salary levels are rising.

"D. Fragmentary local data indicate that there are more jobs than applicants in most instances checked. One large firm reports successful hiring of only 1/3 of its expressed needs for 1956.

"E. Many technical schools are now supported in part by industry and public agencies to assure a flow of trained technicians. Demand has forced the development of technical institute type curricula in the major fields.

"F. Industrial advertising in newspapers, technical publications, school newspapers, and handbills and other media is evident in almost all major industrial centers.

"G. Despite extensive training programs and various improvements in career incentives, the military services are faced with persistent shortages of technicians who are urgently needed to man and maintain our complex new weapons systems. The military services are constantly losing such people to industry, which also needs them. The problem is national in scope. Increased training to improve our supply and quality of technicians is, therefore, necessary to meet national defense needs as well as of a healthy civilian economy."

DISCUSSION

of Technical Papers and Other Articles

LATERAL RIGIDITY OF STEEL BUILDING FRAMES

J. L. de Stein, M.E.I.C., and J. O. McCutcheon, M.E.I.C.

The Engineering Journal, 1956, October, 1943

T. R. Higgins[1]

Quite apart from what lateral deflection limitation ought to be placed on rigid frames having frangible cladding, the extensive data contained in the article "Lateral Rigidity of Steel Building Frames" serves a very useful purpose in evaluating the stiffening effect of semi-rigid connections used in lieu of full continuity. It will come as no surprise to most engineers that web connections alone are seriously deficient where frame action is required to resist horizontal forces. The much more favourable behaviour of the flange type semi-rigid connectons, in the case of buildings of usual span-to-column height ratio, may not have been as well understood.

The authors' designs call for columns having flanges approximately equal to their depth, i.e., "column" shapes, together with girders of greater depth. This may have been dictated by the details of the semi-rigid connections. It should be noted, however, that in present-day practice in rigid frame design, the girders and exterior columns are generally proportioned to have approximately the same depth and moment of inertia. This practice tends to reduce the lateral deflection resulting from horizontal loading, without increasing the weight of the frame. Hence, the deflections given in Table I are somewhat in excess of those we might expect using typical rigid frame designs.

For example, Frame S 20-1-15 might have employed a 10WF 25 for the rafter instead of a 12WF 27, and a 10WF 29 for the columns instead of an 8WF 28. In fact, a 10WF 25 would be "overstressed" less than 7 per cent, if used for the columns. The total weight, even using the heavier 29 lb. shape for the columns, would be 0.7 per cent less than the authors' frame S 20-1-15. The lateral deflection would be 18 per cent less.

The authors' conclusion (4) should be re-examined on the basis of the more general practice of employing the same rolled shape for the exterior columns and girders. Using a load factor of 1.88 for vertical loading only, and 1.41 for combined wind and gravity loading, plastic design would give a 10WF 25 for the entire frame. At working loads the lateral deflection of such a plastically designed frame would be slightly less than for the authors' design.

[1]Director of Engineering and Research, American Institute of Steel Construction, Inc., New York.

THE KAPLAN TURBINE IN CANADA

G. Dugan Johnson, *S. Morgan Smith Company, York, Pa.*

The Engineering Journal, 1956, June, 769

G. G. Fintak‡

The author's interesting presentation of the advantage of the Kaplan turbine should greatly encourage and increase the application of the Kaplan type adjustable-blade turbine in the future development of Canada's hydro - electric potential. However, there are a few items in connection with this paper that might be brought out or further stressed.

The author calls attention to the development of the fixed-blade propeller turbine in 1913 and the Kaplan type adjustable-blade turbine in 1919 with the first fully automatic Kaplan type adjustable-blade turbine installed in this hemisphere in 1929 at the Lake Walk plant of the Central Power and Light Company, of San Antonio, Texas.

It should be added that as early as 1923 an adjustable blade propeller turbine was built by Allis-Chalmers Mfg. Co. for the Inca Mining Copany, Peru. The blades were seasonaly adjusted at the hub by means of bolts and dowels after the casing was unwatered.

In 1925, the first manually adjustable blade propeller turbine, where the blades were mechanically adjusted at the turbine-generator coupling without unwatering the casing but with the turbine at rest, was installed.

In 1926, the first manually adjustable blade propeller turbine in Canada was built by Canadian Allis-Chalmers, Ltd. and installed at the Canada Cement Co., Lakefield, Ontario. This turbine was a 138-inch four bladed runner rated to develop 3,100 h.p., 16 ft. net head, 112.5 r.p.m. In 1927, the 192 in. four-bladed, manually adjustable propeller turbine, installed at the Montreal Island Power and Light Co., Back River plant, set the world's record for physical size for adjustable blade propeller turbines.

In 1930, the Allis-Chalmers Mfg. Co. introduced the "Motormatic" adjustable blade propeller turbine which incorporated an electric motor inside the shaft for adjusting the blade tilt while at rest or in motion.

During the years 1925 to 1932, the writer's company built 40 adjustable blade propeller turbines of the manual or electrically operated type.

The largest physical Kaplan type adjustable blade propeller turbine in this hemisphere today are the six Allis-Chalmers units installed at the Pickwick Landing plant of the Ten-

‡ Application engineer, Hydraulic Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

nesee Valley Authority, each having a 292-inch runner rated 55,000 h.p., 818 r.p.m., 43 ft. net head.

Several high head Kaplan type adjustable blade turbines are in operation in the United States today. The Shepaug Plant of the Connecticut Light and Power Co., built by the writer's company, operates under a maximum head of 99 feet. The Cabinet Gorge plant of the Washington Power Co. operates under a maximum head of 100 feet. It should be noted that the Kaplan turbine at the Shepaug plant has a rivetted plate steel full spiral casing.

Unlike the case in Europe, the Kaplan type turbine for high heads (over 100 feet) has not gained favour over the Francis turbine due to the low settings required and the correspondingly high excavating costs.

The author mentions that considerable leakage of water into the runner hub has been experienced. The double seal arrangement at the blade trunnion of the Allis-Chalmers design has reduced leakage to a minimum requiring little maintenance and negligible seal and oil replacement. The minimum leakage also eliminates the necessity for automatically recharged air pressure tanks to maintain definite pressure inside the hub.

Recent index tests of the Kaplan type adjustable blade propeller turbine at the Rock Island plant of the Washington Power Co., Box Canyon plant, PUD No. 1, Pend Oreille County, Washington and Shepaug plant, Connecticut Light and Power Company, give further emphasis to the author's illustration of the flat efficiency horsepower curves for wide head ranges obtainable by modern Kaplan turbines.

The importance of the hydraulic laboratory investigations cannot be stressed enough, not only model testing for new plants under construction, but equally important for plants being modernized.

Usually, the physical dimensions of the plant considered for modernization restricts the draft tube and casing proportions which are important factors affecting the performance of the turbine. Therefore, it is essential that the complete turbine, inlet and discharge water passages, draft tube and setting of the plant be model tested in the laboratory and contract performance based on these tests.

We agree with the author's statement that it is practically impossible to conduct a reasonably accurate field acceptance test in accordance with any approved test code on units having a concrete semi-spiral casing. Recent field tests made on concrete semi-spiral casings with properly installed Gibson piezometers have decidedly shown unequal velocities in the inlet channels to the turbine which indicates unequal flows, tending to make a Gibson test inaccurate on this type of casing.

Research and experience with the Gibson method has also shown that turbulence near the Gibson piezometers can have a large effect on the accuracy of the discharge measurements. Since the upstream piezometers on concrete semi-spiral casings by necessity usually have to be located near the intake where considerable entrance and rack turbulence is present, the accuracy of Gibson tests on this type of casing seems to be in question.

J. G. Warnock **

Mr. Johnson's paper, "The Kaplan Turbine in Canada", gives a very useful survey of the present status and future possibilities of the application of this type of design to Canadian installations. I find that the paper corroborates many of my own sympathies in this direction, and I certainly hope it will stimulate further thought by those responsible for selecting type of plant, particularly for marginal applications.

Mr. Johnson mentions the advantage of Kaplan type units in maintaining automatically maximum station efficiency, even with slight variation in demand, head or flow, and it is agreed that this is an advantage to be considered when contemplating the use of Kaplans for a large multi-unit installation. Even where head, total output, and flow variations are not great, the inherent overload of the unit at "full tilt" capacity may conveniently be called on to provide extra plant capacity for use on occasions when one of the units may be out of service for maintenance. For example, application of 28 Kaplan machines to a development similar to the St. Lawrence power project would perform a similar function to say 32 fixed blade propellers without change in physical size of unit, and ensure maximum efficiency operation for by far the major proportion of the time. Resistance to cavitation pitting would also be greater due to the use of the precisely correct blade angle for each output condition. Admittedly, even with the reduction in the number of Kaplan units, generators and associated equipment, the total plant cost would be higher, but instances will certainly arise where the additional capital cost can be fully justified by additional revenue from higher average operating efficiency.

In the future application of Kaplan units in Canada, heads of up to 200 feet may certainly be considered with conventional axial flow units and considerably higher heads with the more recent diagonal flow variable pitch propeller unit.

A 28,000 h.p. Kaplan unit, under 188 foot head, is among the highest head applications in operation in Europe. A particularly large hub to tip ratio, eight blades, and full spherical skirt over the running clearance with the blade tips are all special features associated with the high head Kaplan unit.

The blade control mechanism of all Kaplans manufactured by the firm with which I am associated, is located within the hub itself, and no special servomotor in the main shaft or heavy linkage is required.

Turning now to even higher head applications, Mr. Johnson has developed his excellent description of the hydraulic aspects of the Kaplan from consideration first of the fixed blade propeller associated, until a few years ago, with heads of under 60 feet. In the alternative approach, the principles of the mixed flow Francis type wheel commonly applied to heads of from 50 to 1500 feet have been applied to the standard Kaplan axial flow, which is quite at home, as we have seen, between 20 and 200 feet, to produce the mixed flow variable pitch design, or Deriaz runner, after its inventor, our chief hydraulic designer. This design is applicable to heads of 300 to 350 feet and even higher.

The first application of this form of design following generally Kaplan principles will be for reversible pump - turbine duty as listed and mentioned by Mr. Johnson in his paper. Six of these units developing 45,500 b.h.p. at 92.3 r.p.m. under 83 feet will be installed by the Hydro-Electric Power Commission of Ontario at their Sir Adam Beck - Niagara development. In this case the diagonal flow principles have been necessary to develop the 90 foot pumping head in a single stage from a runner following Kaplan principles.

With both these high head Kaplan applications, steel plate scroll cases are, of course, used. From hydraulic

** Head of Hydraulic Department, English Electric Company of Canada Limited.

design considerations the complete and circular spiral form presents no additional problems than arise with the concrete semi scroll case which has been commonly associated with Kaplan applications.

We are fully in agreement with Mr. Johnson's emphasis on the importance and value of hydraulic laboratory tests in the design and development of Kaplan type turbines. The design of high head and Deriaz runners for the Niagara units have been possible only after the most exhaustive testing of various forms of turbine and blade shapes in our extensive laboratories in Rugby, which are largely engaged on development work for the Canadian market.

It has been found from both aerodynamic and hydraulic model testing at these laboratories that the semi scroll case as well as the draft tube design may have appreciable bearing on ultimate efficiency, and may show substantial deviations from open flume tests. We would, in fact, recommend that development programs, too, include tests with completely homologous water passages from inlet to discharge. We would agree that the draft tube form is also particularly important as it is on the efficiency of this vital part of the Kaplan turbine that recovery of the shock losses in the kinetic energy at discharge depends.

I am particularly interested in the references to means of restricting runaway speeds as it is the firm with whom I am associated that has applied the use of a hydro brake for this purpose. As mentioned by Mr. Johnson, present practice in generator design appears to have largely overcome the problem by a careful distinction between "theoretical" or off-cam and "practical" or on-cam runaway speeds. There will, however, be cases in the future where very wide head variations on low head developments will cause runaway speeds of perhaps 4 to 5 times normal, resulting in excessively high runaway stresses. We have in mind particularly tidal projects where the full tidal ranges must be utilized. When the time comes to develop these tidal projects with their enormous potential there may arise a very definite need for some reliable means of restricting runaway speeds.

I would like to congratulate Mr. Johnson on an excellent presentation of this most interesting paper. The occasion of its presentation is timely in that the plentiful resources of water power, particularly in Ontario, are diminishing, and more attention will have to be applied to sites with less attractive hydraulic considerations, where the Kaplan turbine may well give the optimum selection of plant.

R. S. Sproule †

The author should be congratulated on this paper, which should achieve its object: "To encourage increased use of the Kaplan adjustable blade propeller turbine in the continuing development of Canada's hydro-electric potential." The writer is also enthusiastic about the future of the Kaplan turbine but not quite to the same extent as the author. Exception must be taken to the statement that "because of the resulting high average operating efficiencies the use of the Kaplan runner instead of Francis or propeller wheels permits a considerable reduction in the number of units in any particular power house without any reduction in the total annual power output from the available supply of water." Where flow conditions are steady, the fixed blade propeller is superior to the Kaplan because of its lower cost and higher peak efficiency. The cost is lower because of greater simplicity. The peak efficiency is higher because with a fixed blade propeller turbine more favourable shapes of hub and throat ring are possible, the hub can be smaller, and the running clearances can be smaller. For a turbine designed for peak efficiency at a given power and a given head the Kaplan turbine has to be fully as large as the fixed blade propeller, and even somewhat larger because of the relatively larger hub required for the Kaplan. If some sacrifice in efficiency at rated power is permissible then the Kaplan turbine can be made smaller.

Reference to the author's Figure 3 will demonstrate that at any given power and head the Kaplan turbine operates as a fixed blade propeller turbine and the high unit powers, or high powers for a given turbine size, obtained with Kaplan turbines are accompanied by some loss in efficiency compared to the point of peak efficiency. For example, a fixed blade propeller turbine of the design on which Figure 3 is based with the runner blade set at 28 degrees, would give 129,000 h.p. at 89 feet head with an efficiency of 93 per cent. Somewhat better could be expected from a fixed blade turbine designed to operate at this point only. Figure 3 also demonstrates graphically how much superior the Kaplan turbine is to the fixed blade propeller when operation is desired over a range in power or when high power is wanted at reduced head and the accompanying loss of efficiency is acceptable.

†Manager, Hydraulic Division, Dominion Engineering Works.

The Editor invites written discussion of articles that appear in *The Engineering Journal* or other subjects.

S. Logan Kerr*

The only question that I would raise is the one discussed by the author under the heading "Contract Model Tests and Field Tests" (on pages 775 and 776) which is somewhat broader than the actual conditions that exist and is not accepted as standard practice to eliminate field tests and use the laboratory model tests exclusively for establishing guarantees.

The ASME Code, paragraph 4, (reference 8 in the paper), is very specific about this and does not specify the Moody formula for stepping up the results, but only mentions that "the method of allowing for scale effect should be agreed upon by the representatives of both parties to the contract." In the supplement covering Index Tests, paragraph 4, it is very specific in stating "the Index method of testing should not be used as an acceptance test of a hydraulic turbine to determine whether it meets the contract guarantee."

I feel that this matter should be pointed out clearly and not indirectly infer that such procedure as outlined in the third paragraph under "Contract Model Tests and Field Tests" (page 776) is covered by the ASME Power Test Code. This, of course, is not the case and the words "actual prototype efficiency horsepower curves" are really the estimated prototype efficiency curves. There is a great difference between the actual and estimated curve, particularly since the so-called Moody formula or the Ackeret formula have not been confirmed by extensive comparisons on field tests and are empirical formulas only.

* International president, TC4/IEC—Hydraulic Turbines, Flourtown, Penna.

Further discussion of "The Kaplan Turbine in Canada" will appear in the March issue.

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

PAPERS OF THE INSTITUTIONS OF CIVIL, ELECTRICAL, AND MECHANICAL ENGINEERS

Copies of many of the papers of the respective Institutions of Civil, Electrical, and Mechanical Engineers, in Britain, are made available to the Engineering Institute of Canada and form a valuable addition to the Institute library. It is proposed to publish abstracts of those papers which appear to have particular interest for the professional engineer in Canada.

In the meantime, there appears below a list of the papers received recently of which a copy is held in the Institute library.

The Institution of Civil Engineers
The Institution of Mechanical Engineers
The Institution of Electrical Engineers

The second Graham Clark Lecture: The impact of engineering on society; Sir Maurice Bowra, warden of Wadham College, Oxford.

The Institution of Electrical Engineers

The dual-input describing function and its use in the analysis of non-linear feedback systems; J. C. West, J. L. Douce and R. K. Livesley.

A bridge for the measurement of permittivity; A. M. Thompson.

The indirectly heated thermistor as a precise a.c.-d.c. transfer device; F. C. Widdis.

Time sharing as a basis for electronic telephone switching (A switched-highways system); L. R. F. Harris.

Temperature rises in electrical machines as related to the properties of thermal networks; J. J. Bates and Prof. A. Tustin.

Nuclear - reactor - control ionization chambers; W. Abson and F. Wade.

Temperature rises in electrical machines on variable load and with variable speed; Prof. A. Tustin and J. J. Bates.

Underground lighting in coal mines; C. D. J. Statham.

Performance and heating curves for motors on short-run duties; Prof A. Tustin, D. F. Nettell, and R. Solt.

Some design aspects of nuclear-reactor control mechanisms; G. E. Lockett.

The application of transistors to the trigger, ratemeter and power-supply circuits of radiation monitors; E. Franklin and J. B. James.

The control and instrumentation of a nuclear reactor; A. B. Gillespie.

A point-contact transistor scaling circuit with 0-4 microsec. resolution; G. B. B. Chaplin.

The control of nuclear reactors; R. J. Cox and J. Walker.

The Crystal Palace television transmitting station; F. C. McLean, A. N. Thomas, and R. A. Rowden.

The Broadcasting House-Crystal Palace television link; A. R. A. Rendall and S. H. Padel.

Band I television-transmitter design, with particular reference to the transmitters at Crystal Palace; V. J. Cooper and W. J. Morcom.

A junction - transistor scaling circuit with 2 microsec. resolution; G. B. B. Chaplin and A. R. Owens.

Mine locomotives; T. E. Green.

The Institution of Mechanical Engineers

Behaviour of rubber in compression under dynamic conditions; H. McCallion and D. M. Davies.

Heat transfer in pipe flow at high speeds; J. E. Bialokoz and Prof. O. A. Saunders.

Symposium on nuclear energy: (1) Nuclear reactors for power generation; B. L. Goodlet. (2) Steam cycles and nuclear power plant; R. E. Zoller. (3) Heat removal from nuclear power reactors; Prof. J. Diamond and W. B. Hall. (4) Shielding against nuclear radiation; C. E. Iliffe

A standard gas turbine to burn a variety of fuels; G B. R. Feilden, J. D. Thorn, and M. J. Kemper.

Fatigue under triaxial stress: development of a testing machine and preliminary results; Prof J. L. M. Morrison, B. Crossland, and J. S. C. Parry.

The fatigue strength of specimens containing cracks; N. E. Frost and C. E. Phillips

Front suspension and tyre wear (Automobile Division); V. E. Gough and G. R. Shearer.

Forces on a brake block and brake chatter; H. R. Broadbent.

An approach to the techniques of graduate training; D. L. Marples, J. F. A. Radford, and J. L. Reddaway

Crankcase explosions: an investigation into some factors governing the selection of protective devices; H G. Freeston, J. D. Roberts, and A. Thomas.

Crankcase explosions: development of new protective devices; W. P. Mansfield.

A servo-controlled continuous feeder; J. C. R. Heydenrych and U. A. Luoto.

Three-dimensional motion in axial-flow impellers; S. P. Hutton. The performance of an axial-flow pump; E. A. Spencer.

The influence of the gas-turbine axial-flow aero-engine on blade manufacturing methods; R. R. Whyte.

PRECAST BRIDGE UNITS SAVE TIME AND COST

E. F. Bespalow, vice-president and chief engineer, Choctaw, Inc.

Civil Engineering, 1956, November

One of the major road blocks in the highway department is the shortage of civil engineers experienced enough to design the many bridges and structures needed for high standard roads. Since 1936, when efforts were first being made to promote the use of precast units in the United States, it has taken 20 years to reach the stage of development we are in today, the beginning of the utilization of precast and prestressed concrete construction.

Precast concrete bridge units have proved a boon to maintenance engineers. On emergency work they could be delivered from stock and erected at once, thus saving the building and maintaining of detours and avoiding complaints. It is now possible to produce precast units of much better quality and to deliver them at less cost than that of conventional cast-in-place concrete.

They have almost complete salvage value. If the location is changed units can be unbolted and transferred to a new location without loss. For widening a bridge, additional units can be inserted as required. Precast units are ideal for use in detour bridges required during construction of new highways. Standardization in the various states would help reduce their costs. There is a serious need for a realistic specification covering the manufacture of precast units when made up in recognized manufacturing plants.

The economy of this type of construction is demonstrated by the fact that when alternate bids have been taken against other types of construction, in most cases the precast type has proved to be cheaper. Bridges built under contract with precast type units have shown a construction cost in place, completed, of $4 to $5 per square foot, depending on the type of construction used.

TRAINING FACTORY WORKERS

The Times Review of Industry, 1956, Aug.

The report summarized in this article recommends general principles of the utmost value for those training semi-skilled and unskilled workers. The survey was undertaken in the manufacturing industry of Britain as part of a larger investigation organized in seven western European countries by the European Productive Agency, which will issue a general report.

Factories visited include those manufacturing food, beverages, footwear, tobacco, textiles, clothing, footwear, furniture, paper, pottery. vehicles, machinery, steel, chemicals, and goods made of wood, leather, rubber, and petroleum products. Only in eleven of the schemes studied were both financial and non-financial incentives deliberately applied to trainees, while in 113 cases there were no such arrangements.

The general conclusion of the survey is that success depends on suiting the training scheme to the firm and, in particular, to the number of trainees and the nature of the work. A detailed appendix shows how schemes have been applied to a wide range of jobs. The survey, as was intended, must be only the beginning of a determined drive to improve the present haphazard, wasteful and scattered efforts at systematic training which it reveals.

GEODESIC STRUCTURES

R. Buckminster Fuller, well-known American architect, is a pioneer in the design and use of geodesic dome structures, which combine the properties of the tetrahedron and the sphere. Recently, Mr. Buckminster Fuller visited McGill University and supervised the erection of a geodesic dome structure by architectural students of the university. The frame members and panels were aluminum.

TECHNICAL PUBLICATIONS ON PETROLEUM

Many technical papers on petroleum subjects are written each year by the staffs of the companies within the Royal Dutch-Shell Group and form a valuable contribution to the literature. Many of the papers are based on research work done at the laboratories at Amsterdam and Delft, in Holland, and at Thornton, in the United Kingdom. These papers are listed in a catalogue "Technical Papers, 1955" under various sections from history of science and engineering, through various fields of physics and chemistry, to chemical engineering and production processes. There are also papers on industrial and agricultural applications of petroleum products. It is proposed to publish a similar catalogue in subsequent years. Information about the catalogue and papers may be had from the Shell Oil Company of Canada Limited, P.O. Box 400, Terminal A, Toronto 1, Ont.

PENSION WITHOUT TIES

Engineering, 1956, December 7

The Engineers' Guild (in Britain) have brought out a new form of group insurance. The scheme is designed to enable the professional engineer to make arrangements for death cover or pension which will be independent of the continuity of his employment in any one organization, or, if self-employed, which will benefit from the lower rates open to group schemes. No longer need pension considerations deter engineers from "striking out into new fields to widen their experience and to gain opportunities for using their abilities to the full." Conversely, companies will be freed from the difficulties of fitting older, experienced engineers into existing group pension schemes.

Various features of the scheme combine to make it attractive, especially to the young engineer who wishes to gain experience with several firms before settling down. The employer can pay all or part of the contributions as he wishes; all contributions qualify for income tax relief; individual evidence about health is not required for the first £2,000 insured; and the age at which a pension is payable can be selected (within certain limits). It would thus seem to offer all the advantages of company-run schemes without any of their disadvantages.

The scheme is open to members of the Guild, or to those eligible for membership: namely, members of the Institutions of Civil, of Mechanical, and of Electrical Engineers aged between 21 and 60. The details are set out in a booklet "Pensions for Professional Engineers", published by the Engineers' Guild Limited, 78 Buckingham-gate, London, S.W.1.

WORLD'S LARGEST DISCHARGE TUNNEL

A discharge tunnel two-and-a-half miles long with a section of 4200 square feet, said to be the largest in the world at present, is a feature of Sweden's biggest power station (390,000 kw, installed capacity) now under construction at Stornorrfors by the Swedish State Power Board. More than two million cubic yards of material will have to be excavated for the tunnel. The picture shows thirteen chain-fed drills carried on a rig on one of the two final stages of the benching operation in which crews were drilling 500 feet per man-shift. Lightweight rock drills mounted on pusher legs were used to drill the 1720 sq. ft. top heading. (Atlas Copco Canada Limited.)

ACCOUNTING RATIOS FOR INTERFIRM COMPARISONS

Times Review of Industry, 1956, November

There are a number of ways in which firms can make use of reasonable, simple ratios drawn from their accounts, but probably most businessmen look for a major indication of business success in their return on capital. A primary ratio is the return on capital employed. This should be represented in current money terms, which usually means adjusting the book values of fixed assets to bring them in line with current replacement costs. If the firm carries on more than one homogeneous business, separate statements of capital employed should be prepared for each.

Return on capital can be expressed in terms of net profit. If a firm finds its return on capital employed is lower than that of most other firms in its own industry then it should look for reasons by examining how it stands in relation to secondary ratio comparisons. This it will look to see whether other firms have achieved a faster turnover of capital by inspecting the rates of sales income to operating capital employed.

On another plane of reference, secondary ratios should be used to investigate whether other firms have obtained higher profits on sales because they operated on lower cost levels.

The primary purpose of interfirm comparisons of accounting ratios is to indicate to the management of firms in the same industry significant variations between the internal accounting ratios of the firm and similar ratios of other firms, to reveal any weaknesses in the financial structure or deficiencies in the profitability of the firm.

In examination of the principles and purposes of accounting ratios, it must be realized they will indicate no more than the direction in which improvements within a business must be sought, and a broad guide to the possible scaled improvement. No one ratio should be relied upon in isolation. It is desirable to keep to a few selected strategic ratios, and upon the interdependence of accounting aggregates by assuming that all other sub-relationships will more or less respond within the constraints of the accounting framework.

THE EXECUTIVE JOB AND THE ENGINEER

Dr. F. J. Gaudet, Stevens Institute of Technology

The American Engineer, 1956, Dec.

Fifty per cent of all major executives in American business are now at the age where they have to be replaced in the next few years. Who will replace these top executives? The group aged 35 to 45 is poorly represented. Ten or fifteen years from now there will be even a greater dearth of available top management.

In the last ten years, the greatest emphasis in recruiting for industry has been placed upon the engineering graduate. But some industries have found engineers are not solving all their management problems. Some top executives say: "Engineers are too specialized" . . . "They know too little about human relations," and so on.

The author, who has been consultant to many companies in evaluation development of management personnel, summarizes in this article his ideas about the training of the potential executive, what he should know and what background he should have. Whether it be engineering, law, business administration or the liberal arts, he points out, it is not the school which makes the man narrow or broad in his range of interest.

All schools have some students who are rigid personalities and some who are flexible. What industry or business will get from any of these schools will depend upon their method of selection and, having selected the right man, the opportunities for growth and development that are afforded him while he is in their employ.

doubling that quantity. Mechanical pulp will be manufactured first, and chemical pulp bought as semi-bleached kraft; eventually chemical or semi-chemical pulp will be made and bleached at Tuxtepec.

The paper machine will be a 181-in. fourdrinier with submerged screens, a pressure inlet, conventional open-transfer press section, enclosed dryers, calender, reel and winder, all driven by a line-drive shaft and variable speed steam turbine at a rated speed of 1150 feet per minute.

Process steam will be generated in two oil-fired low pressure boilers; electric power will be purchased. Process water will come from shallow wells in the gravel beds of the adjoining river, fed by gravity from a reservoir.

Main process equipment will be in a single two-storey reinforced concrete structure, serviced by travelling cranes from pulpwood grinding to paper finishing area. Storage areas, repair shops, laboratories, and mill offices will be in a parallel annex. The main structure will have a unique system of criss-crossed column and multiple-arch thin shell roofs, with suspended aluminum ceilings forming an integral part of the ventilating system. All walls will be lined inside and out with domestic tile.

Construction is scheduled for the mill to be ready for operation early in 1958. Building contractors are Ingenieros Civiles Asociados, of Mexico City.

INFLUENCE OF NAIL DESIGN ON JOINT STRENGTH

A. B. Dove, M.E.I.C., The Steel Company of Canada Limited

Wire and Wire Products, 1955, June

The full title of this paper, which won the 1955 award of The Wire Association as the most meritorious paper on wire manufacture or fabrication, is "The influence of nail design and manufacturing practices on joint strength".

Research conducted during the development of an improved common nail gave a close study of some of the factors that influence the strength of nailed timber joints. The paper deals with the investigations and the results obtained with various different types of nail, of which the characteristics are given. Some of the subjects considered are: wood structure and the effect of nail penetration; holding power of nails; the influence of extent and type of deformation; bending during driving; effect of heat treatment; flooring nails; splitting effect; and the lateral strength of nailed joints.

PASSENGER AIRLINE ECONOMICS

Lloyd B. Aschenback, Douglas Aircraft Co. Inc.

Aeronautical Engineering Review, 1956, December

In this article, market research techniques are used to study the factors affecting the air travel industry, with specific reference to the problem of traffic forecasting.

As an industry, the author finds, common carrier traffic is losing in the competitive race for a share of the consumer dollar. Air travel purchased per dollar of national income is increasing, but the amount of surface travel is decreasing. Present indications are that air will continue to increase its percentage of total common carrier travel. As this occurs it may be possible for common carrier travel to regain its competitive position for the consumer dollar.

Based on a national income forecast developed by the Joint Committee on Economic Report of the Congress, by the use of numerous graphs and charts, travel trends are forecast with the resulting relative values for each type of transportation.

The CAA has grouped all cities served by airlines into four classes: marketing, institutional, balanced, and industrial. By the use of several economic factors a symptomatic index of the buying potential of a city can be assigned. Elements of the index are population of the area, retail sales and disposable income.

For instance, a city classified as industrial will not, as a rule, generate as many passenger miles as a city classified as marketing or institutional. By relating the growth rate of a region to the economic and air-travel growth rates for the nation, an air passenger traffic forecast can be made for a specific region.

The article concludes with a discussion dealing with the equipment needs of the specific airline, both for short-to-medium range and long range flight segment lengths. Having the best equipment available to do the most economical job, the airline turns to the scheduling and type of service requirements in its region of operation, paying close attention to the desires of its customers. When all these elements are considered and properly weighted, the purchase of suitable airplanes may be made.

THE TUXTEPEC PULP AND PAPER PROJECT

J. S. Motherwell, Sandwell International Limited

Papermaking, in the European sense, has been carried on in Mexico since 1580, though paper had been made from the inner bark of trees in the Aztec empire — an art which still survives in places. Now, a modern newsprint paper mill is being constructed near the village of Tuxtepec, in the Papaloapan basin, an area of some 17,000 square miles north-east of the Isthmus of Tehuantepec.

The mill, of the Fabricas de Papel Tuxtepec, is the first major industry since the government-established Comision del Papaloapan introduced flood control and power production to the area. The project owes much to Canadian experience, the consultants being Sandwell International Limited and the equipment contractors Parsons and Whittemore Development Company, of St. John, N.B.

Initial rated annual capacity of the mill will be 30,000 metric tons of newsprint, with a provision for at least

ADVANCED STEAM CONDITIONS

The most advanced steam conditions ever commercially used in Britain will be in operation in a new extension to the B power station at the Margam steelworks in South Wales. The plant will generate 240,000 lb. steam per hour at 3300 p.s.i. and a temperature of 1060 deg. F. with reheat to 840 deg. F. using a Benson forced-circulation boiler. This is a joint project of the Steel Company of Wales and Simon-Carves Ltd.

FIRST SWEDISH NUCLEAR POWER PLANT

Bureau de Presse Suédo-Internationale, Stockholm, 1956, Dec. 12

The first nuclear plant in Sweden for the production of heat and power will be built to serve Farsta, a new autonomous suburb of Stockholm with a population of 50,000. The program is to be completed in 1960.

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

Ontario Hydro's new chairman, James S. Duncan, C.M.G., has made a first-hand inspection tour of the St. Lawrence development. In December, he visited the construction work on both sides of the International Rapids section. He also toured the new townsites on the north shore and saw the rehabilitation work in progress.

Mr. Duncan inspected the power-house site, the Long Sault and Iroquois dams, and channel improvement work. He also saw construction work at Eisenhower lock and Iroquois Point.

"I am sure from what I have seen in my inspection trip, that this power development will be constructed on schedule and meet the target date for first power in the summer of 1958", Mr. Duncan stated.

Progress by Ontario Hydro

Throughout December, variable weather conditions offered some difficulties for construction. The work force amounted to 3,900 persons. Excavation for all features exceeds 24 million cubic yards and concrete placement exceeds 575,000 cubic yards.

Placing of concrete on the Canadian half of the power-house site continued despite winter weather of varying degrees of severity. On the average, 10,000 cubic yards of concrete were placed each week throughout December and by month end a total of 405,000 cubic yards had been put into the power-house.

Installation was well under way at the end of December on the first and second turbine units. Erection of No. 6 draught tube form was completed early in the month and placing of concrete in that area was started.

Paving operations on new No. 2 highway had been commenced in the vicinity of Long Sault (town No. 2). The contractor had completed ten miles between Long Sault and the Aultsville road intersection.

At Galops Island, rock and earth excavation work had proceeded well despite the unfavourable weather conditions. The big 14-cubic-yard dragline "The Gentleman" had been added to the contractor's equipment and was ready for operation throughout the winter months. A total of 7,520,000 cubic yards of rock had been removed in this contract.

Splendid progress had been made in excavation work at Iroquois Point. The cofferdam there had been joined to the seaway canal cofferdam. Closure of the river was completed during the month.

In other areas of the project, good progress was made. The ballast laying had been fully completed for the Canadian National Railways double track section between Iroquois and Cornwall. On the diversion canal, the excavation both east and west of the closure structure was essentially completed.

Some 20 homes had been transported to Ingleside (town No. 1) by the end of December. Erection of the water tower was about 90 per cent completed and the sewage treatment plant was almost ready for operation. In Morrisburg area, five houses were moved to clear the access road. Work was continuing on water and sewage pumping stations and services. Foundations for the new shopping centre were completed.

At Iroquois, construction mainly was centred on the shopping centre. Some stores would be ready for occupancy early in the New Year. Work of building schools and churches in New Iroquois was progressing well. At Long Sault (new town No. 2), construction of the shopping centre footings was under way. Work in the new town site was being centred on completion of improvement work on new houses moved there, and on general clean-up. To date, 284 of the required 500 houses had been moved to the various town sites.

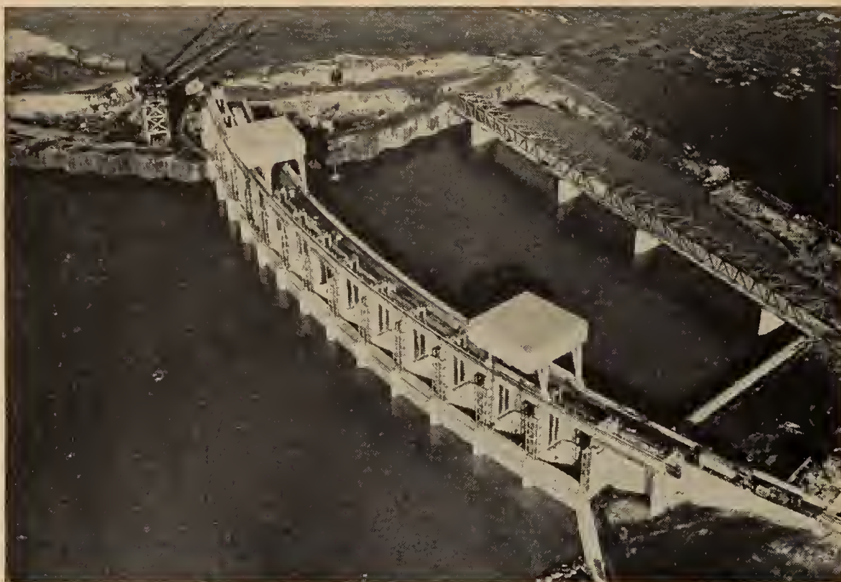
Hydro's Winter Concreting

Winter will not halt concrete placing operations on the power-house site in the Ontario Hydro section of the St. Lawrence development. This work will proceed around the clock all winter long with an average of some 10,000 cubic yards of concrete placed per week. Already, a total of some 400,000 cubic yards or about 40 per cent of the total for the Ontario Hydro half of the power-house, has been placed.

The greatest care and vigilance must be maintained at all times, day and night, to assure that there is no thermal shock which may damage the concrete. But, with experienced concrete control engineers and construction men on the job to check conditions, successful concrete placing operations can be carried out even in the severest winter weather.

Progress by NYSPA

December was marked by diversion of the entire flow of the river through the completed portion of Iroquois dam. Overall construction was on schedule as concrete placement to date exceeded 910,000 cubic yards and excavation for all features exceeded 33 million cubic yards. Employment averaged 3,100 for the month.



Long Sault dam. Stage I construction area had been flooded.

At Long Sault dam, removal of cofferdams A and B was completed, cut C was plugged, and the entire flow of the south channel was diverted through the completed portion of the dam on December 3, 1956. Balancing of the head on both sides of the upstream plug at cut F was completed and breaching of the plug was initiated on December 26, 1956, by blasting the first section of the plug.

Concrete placement in the American half of the Barnhart Island powerhouse increased the total placed to date to 438,000 cubic yards. Concrete was placed in the scroll case walls, stay ring erection piers, and in the ice sluices.

At Iroquois dam, thirty-five of the forty stage II cofferdam cells had been placed to the end of December. Removal of the downstream stage I cofferdam was completed. The rock groin dike was closed on the Canadian shore, diverting the main river flow through the completed portion of the dam.

At Massena intake, Stage II cofferdam cells were being placed. Structural items, piping, and mechanical and electrical equipment were being installed in the pump room, control room, and stairway.

Excavation under the five channel improvement contracts was approximately 56 per cent completed. The contractor for the Chimney Island area stopped dredging operations for the season on December 17, 1956. Channel improvement work at the other areas is continuing.

Construction work on the relocated highway routes 37 and 37B was progressing ahead of schedule. Concrete placement for the abutments of the Big Sucker Brook bridge and the piers of the Brandy Brook bridge is being continued.

Work continued on the rehabilitation of the Massena-Taylorville transmission line. Continued progress was being made by the four reservoir clearing contractors as well as the contractor clearing the Barnhart-Plattsburgh transmission line right-of-way.

As the design work moves into its final phase, there is much activity in the preparation of specifications for purchasing various pieces of auxiliary equipment.

Progress by SLSDC

At the end of the year, with 200,000 cubic yards of concrete placed in the Grasse River lock and 250,000 yards in the Eisenhower lock, and progress well up to schedule, excavation on the $6½ million Long Sault canal contract was the only portion of the work on which concern was felt for the rate of progress achieved. Here the contractors have put in a claim for an extra $5½ million, claiming that the glacial till was found to be "cemented".

Work on channels and locks on the American side was closed down for the holiday period. Work on clearing will continue throughout the winter however, as well as on certain portions of the channel excavation.

Progress By SLSA

SLSA President Lionel Chevrier, in a year-end announcement, stated: "At year's end we can say that nearly half the work on navigation channels, locks and bridges on the Canadian portion of the seaway has been completed". Contract awards at year end totalled $190 million out of an estimated total of some $205 million.

Of an estimated total of some 51 million cubic yards of excavation about 60 per cent had been moved. Of an estimated total of some 18 million cubic yards of dredging, 40 per cent had been dredged to date. Out of a total of two million yards of concrete in locks, bridge piers and abutments nearly 20 per cent had been placed.

Freeze-up had closed down dredging operations for the winter months, though some rock excavation was being continued. Placing of concrete for the Iroquois and St. Lambert locks will continue during the winter. Work will be continued on three contracts for excavating the Welland ship canal in the dry during the winter season while navigation is closed.

Construction of Bailey bridges, commenced in late November to permit diversion of highway traffic between the south end of the Jacques Cartier bridge and the navigation channel, was continuing. As soon as completed, work will commence on a new abutment on the Longueuil shore and on the long task of gradually raising the bridge itself.

At Victoria bridge a lift-span for rail and highway traffic will be provided across the St. Lambert lock, while a second lift span for road traffic only will permit vehicles to to be diverted along one of the lock walls and to cross the lock further upstream at times when ships are holding up traffic over the main rail-highway lift span.

Opposite Lachine, a new lift-span will carry rail traffic on the CPR Caughnawaga bridge across the seaway channel, while the south end of the Honore Mercier bridge will be raised in a pattern similar to that being followed on the Jacques Cartier bridge, to give 120 feet clearance for ocean shipping. Work is already under way on construction of approach roads at the south end.

SLSA Contract Awards

A contract for the supply and erection of the vertical lift span superstructures of two bridges was awarded on December 6 to Dominion Structural Steel Limited, of Montreal, at a price of $6,343,146. The bridges are the St. Louis bridge and the Valleyfield bridge. Each carries railway and highway traffic over the

Beauharnois canal. The work is to be entirely completed by November 15, 1958.

A contract for the substructure of a high level suspension bridge across the south channel of the St. Lawrence at Cornwall Island, was awarded November 30 to McNamara Construction company, Limited, of Toronto, at a total estimated cost of $1,240,550.

It is to be completed by August 31, 1957. The bridge, for which the SLSDC is building the superstructure, will be a two-lane highway crossing between the United States mainland, approximately 8 miles northeast of Massena, N.Y., and Cornwall Island.

Assurance has been given by SLSDC and SLSA engineers that this bridge, to be completed for July 1958, will meet schedule requirements.

McNamara Construction Company Limited, was awarded the contract on December 21, for dredging in the north channel of the St. Lawrence River, at Cornwall Island. Value of the contract is $3,574,000, the work to be completed by October 31, 1958.

Dredging under this contract extends from a point near the eastern end of Cornwall Island up to a point just short of the downstream entrance to the Cornwall canal. A contract for dredging the seaway channel in Lake St. Francis, previously awarded, abuts this new contract on the east.

Alternate Canadian Channel

Terminating a controversy of many months duration respecting the dredging of an alternate navigation channel through Canadian territory on the north side of Cornwall Island, the United States was told formally early in December that Canada intended to override American objections to an all-Canadian seaway. At the same time Canada assured the United States she would not complete this all-Canadian channel for at least ten years, or unless traffic became great enough to warrant the opening of a second route. Any formal moves towards completing an all-Canadian seaway would be taken only after Canada had consulted fully with American authorities.

While dredging this Canadian channel now will add some $17 million to the overall cost of the project, carrying out the work now to a depth of 27 feet will mean an ultimate cost to Canada of some $50 million for the alternate channel including lock facilities, as against a possible cost of upwards of $100 million several years from now.

The controversy regarding an all-Canadian channel to duplicate that portion of the seaway now being built on the American side of the International Rapids section, including two locks, arose from the question of the imposition of tolls. The United States favours high tolls as a form of protection for the American merchant fleet which is being subsidized by the U.S. government.

Canada, on the other hand, favours low tolls to permit low-cost foreign shipping to operate economically on the Great Lakes. A foreign customer for Canadian wheat, for example, pays for its transportation. Thus payment for wheat carried in a Canadian ship is proportionally higher than if the customer used his own vessel. Some incentive must be present in the form of navigation facilities at low cost. But U.S. policy on shipping differs from that of Canada because of the insistence that overseas shipping is an essential industry and because the American government must be in a position to supply shipping needs in the event of a war.

Joint Statement by the Two Seaway Authorities

Following a meeting in New York on December 6, it was announced jointly that the Saint Lawrence Seaway Development Corporation and the St. Lawrence Seaway Authority would call for tenders for major dredging and excavation in the channels south and north of Cornwall Island. Bids were to be opened on approximately January 22, 1957.

SLSDC will undertake the dredging in the south channel between mile 107.5 and mile 110 involving work both upstream and downstream of the existing Roosevelt (International) bridge. This channel enlargement will provide a seaway channel of 27 ft. depth leading to the Grasse River lock at the lower end of the Long Sault canal.

SLSA will undertake dry excavation on south part of Cornwall Island in the vicinity of Roosevelt bridge and dredging in the south channel from below mile 109 to mile 112.5 to complete the 27 ft. seaway channel. The Canadian authority will also carry out dredging and dry excavation in the north channel to maintain the natural distribution of flow in the two channels.

It was also announced that the two toll committees representing Canada and the United States are rapidly approaching agreement on principles pertaining to toll rates. However, the committee members agree that studies and discussion of this subject will occupy them for some months ahead.

Seaway News

The U.S. Supreme Court has approved a temporary increase in the amount of water diverted from the Great Lakes into the Illinois River to 10,000 cubic feet per second for a period of 100 days. It is estimated this additional diversion would lower Lake Michigan by about ½ an inch, and would raise levels in the Mississippi River about one foot on the average, thus benefiting river navigation.

Construction progress at Ontario Hydro's power-house project.

Burlington Beach Skyway

The Burlington Skyway

The $13 million Burlington skyway, now being built to replace the Queen Elizabeth way across Burlington Beach at Hamilton, Ontario, is the largest bridge project ever undertaken by the Ontario Department of Highways. Work on the various elements of the substructure are now well along toward completion and erection of the steel superstructure will be carried out throughout 1957. The skyway will be opened for traffic by the end of 1957.

The first road leading from Toronto to Burlington Beach was built in 1808. Since completion of the Queen Elizabeth Way, some 14 years ago, the six-mile, two-lane section of it between Burlington and Hamilton has been a dangerous bottleneck. The 50-mile speed limit on the highway is reduced to 30 through the semi-urban beach area. Local traffic, and heavy truck traffic around north and south shores of Hamilton harbour, have added to the congestion.

Obsolete Bridge Added To Congestion

The existing swing bridge at Burlington beach, or what is left of it, was not erected until 1896. It had to be frequently opened to allow freighters and smaller craft through the ship channel into the harbour. Weekend and holiday traffic during the navigation season is often backed-up for miles in both directions. Then early in 1952 the bridge was wrecked by a ship and had to be replaced by a temporary roll-beam structure on steel piles, closing off half of the 300-foot wide channel.

Discussions between the Ontario Department of Highways and the Federal Department of Public Works resulted in the appointment in August 1954 of Foundation of Canada Engineering Corporation Ltd. as engineers for the design and supervision of a high level bridge across the channel, to be tied in with a new dual-lane highway on a new right of way west of the existing road. Dr. P. L. Pratley, M.E.I.C., of Montreal and Wm. R. Sonter and Associates of Hamilton were engaged to act in association with Fenco on bridge design and on architectural features respectively. Work started in March, 1955.

Foundations

Typical soil conditions disclosed by site investigations showed some 10 feet of loose grey sand, overlaying an average depth of 30 feet of dense sand and gravel, then 80 to 100 feet of compact fine silty material, followed by stiff clayey silt. Since the ground under the bridge was 6 feet or less below water level, it was decided to fill the entire area behind a rock dike with hydraulic sand fill pumped from the harbour, to a height 6 feet above water level. This decision has simplified the entire construction procedure, providing ready access to all points along the site. An estimated half a million dollars has been saved thereby.

To keep differential settlement of the pier foundations within tolerable limits, design criteria based on pier bases at least 7½ feet below ground level and with at least 20 feet of compact sand beneath the base, called for:

(a) untreated class A timberpiles wherever average "N" value of the soil is lower than 15.
(b) maximum load on piles, 22½ tons.
(c) maximum load with no allowance for material excavated, 18 tons.
(d) bottom of pier base not to be above El. 241.5 with top of base not above El. 249.
(e) net increase in soil pressure not to exceed 3,000 psi. on the average or 3500 psi. maximum.

Design of the Superstructure

The bridge structure itself embodies a central span section 1045 feet in length comprising an arch-

like span 495 feet long over the ship channel with two flanking spans each 275 feet in length. On either side of this three-span central section are eleven steel-deck truss spans, followed by nine plate-girder spans each 85 feet long. Total length of the bridge is thus 8,400 feet. It forms part of an extensive dual highway relocation 4.37 miles in length.

Basic requirements for the bridge call for a horizontal clearance of 300 feet across the channel; a vertical clearance of 120 feet above high water in the channel; maximum gradients of 3 per cent as fixed by the Department of Highways; two 24-foot roadways with a 6-foot centre strip; and two 3-foot walkways, one on each side. Design called for safe passage of trucks having a loaded weight of 40 tons or double the loading called for by CSA 1952 specifications. Turnout or parking bays are to be provided for in each directional lane at both ends of the 3-span central unit.

Construction

The concrete work, which covers bridge decking and asphalt as well as the piers, was let under three contracts. Pigott Construction of Hamilton was awarded two contracts comprising separate jobs and the other went to another Hamilton firm, S. McNally & Sons. The total amount of the three contracts is slightly over $2,500,000.

Five separate firms are under contract to the Ontario Highways Department to build the project. Seven different contracts involve six contractors. Different kinds of fabricated steel are necessary, so contracts were awarded three different firms, Bridge and Tank Company and Dominion Bridge of Hamilton and the Toronto firm of Runnymede Structural Steel Ltd.

Dominion Bridge has the contract for the centre span at a cost of $2,405,000. The Bridge and Tank Co. contract amounting to $1,598,700 calls for parquette steel. The largest of the steel contracts and the biggest single contract ever awarded by the Highways Department goes to the Runnymede firm, amounting to $3,932,000.

Building of the skyway involves the placing of some 90,000 cubic yards of concrete and the fabrication and erection of some 20,000 tons of structural steel. Total cost of the entire project, including the controlled access highway at both ends of the bridge, will be approximately $16 million.

Allumette Island Bridges

The end of November saw the completion of the Allumette Island bridge project, a joint effort of the Federal, Quebec and Ontario governments.

The total length of the project is approximately 2 miles. The Ottawa River, at this point, is nearly 1¾ miles wide, and is divided by a group of islands into three channels.

Four Bridges

The Ontario section contains two small bridges. Proceeding from Highway No. 17 near Pembroke, the first bridge is a 172-foot, 3-span, continuous-reinforced concrete overpass which crosses the transcontinental line of the C.P.R. A short stretch of highway connects this bridge with a second smaller bridge of 101 feet overall length. This is a 3-span, reinforced concrete, rigid frame structure spanning Hazley's Bay between the Ontario mainland and Moffat Point. A ½-mile stretch of highway follows on Moffat Point. Bridges and roads in this section have been built and supervised by the Province of Ontario.

The interprovincial channel bridge was built by the Federal Government, Department of Public Works. This is the largest bridge, spanning the interprovincial boundary line and joining Moffat Point to Morrison Island. It is 1,018 feet long, a 7-span continuous steel truss construction, with a concrete roadway slab.

The Quebec section starts with a ¾-mile stretch of highway on Morrison Island. The bridge over the Allumette rapids joining Morrison Island to Allumette Island is 653 feet long. It is a 5-span reinforced concrete structure located entirely in Quebec, with bridge and highway links supervised by the Quebec government.

The north-easterly end of the project terminates at a point between Chapeau and Waltham.

Highway Research

A joint highway research program is in effect in Ontario, the participants being the Ontario Department of Highways, the University of Toronto and Queen's University. Under the plan, started in October, the universities will conduct research on highway engineering problems for which the Department is providing $85,000 to cover costs for the first year.

Minister of Highways the Hon. Jas. N. Allan states that it is hoped that the highway research program will result in economies in the development and operation of the provincial highway system and will interest university students in highway engineering as a career.

Direction of the program will be under a committee with John Walter, design engineer, Department of Highways, as chairman, and F. C. Brownridge, soil and material engineer, as secretary. Other members of the committee are W. J. Fulton, W. Q. Macnee and R. E. Clarke, of the department; Prof. C. F. Morrison, Prof. O. J. Marshall and Prof. M. M. Davis of the University of Toronto; Dr. S. D. Lash, Dr. R. O. Martin and Prof. H. M. Edwards, of Queen's University; A. K. Hay, Ottawa, general manager of the Federal District Commission; and E. W. Jones, president of the County Engineers Association of Ontario. Dr. Lash will direct the work at Queen's, with Prof. Edwards as associate director. Prof. Morrison will be the director at the University of Toronto with Prof. Davis as associate director.

Aircraft Contract

Canadair Limited, Montreal, will supply 225 Canadian Sabre Mark VI aircraft to the Federal Republic of Germany.

The Department of Trade and Commerce announced the conclusion of an agreement in December on the order valued at $75,000,000.

Allumette Island Bridge Project

The production of these aircraft and spare parts will provide employment for more than 3,000 people for approximately two years, and will retain special skills within the industry, while new aircraft programs are being developed.

The effect of this substantial business will be felt from coast to coast in Canada, where there are about 2,000 subcontractors and suppliers serving the aircraft industry. Among the larger subcontractors are: Orenda Engines, Limited, of Toronto; Lucas Rotax Limited, of Toronto and Montreal; York Gears Limited, Toronto.

Athabasca Oil Sands Development

Royalite Oil Company, Limited, Calgary, and its associates plan a $50 million development program in the Athabasca oil sands of northern Alberta.

During two years of intensive research, conducted at a pilot plant at Bitumount, Alta., the company has worked with Can-Amerc Oil Sands Development Company, Calgary, perfecting the Coulson centrifuge process as an economical method of separating the oil from the sands. These oil soaked sands are known by reputation in the exploration and development branches of the oil industry.

Royalite's initial plans call for the construction of a separation plant and a 20,000 barrel per day processing plant on the Company's 50,000 acre lease at Mildred Lake, halfway between Bitumount and Fort McMurray. The Company's property contains, by conservative estimate, a potential one billion barrels of oil.

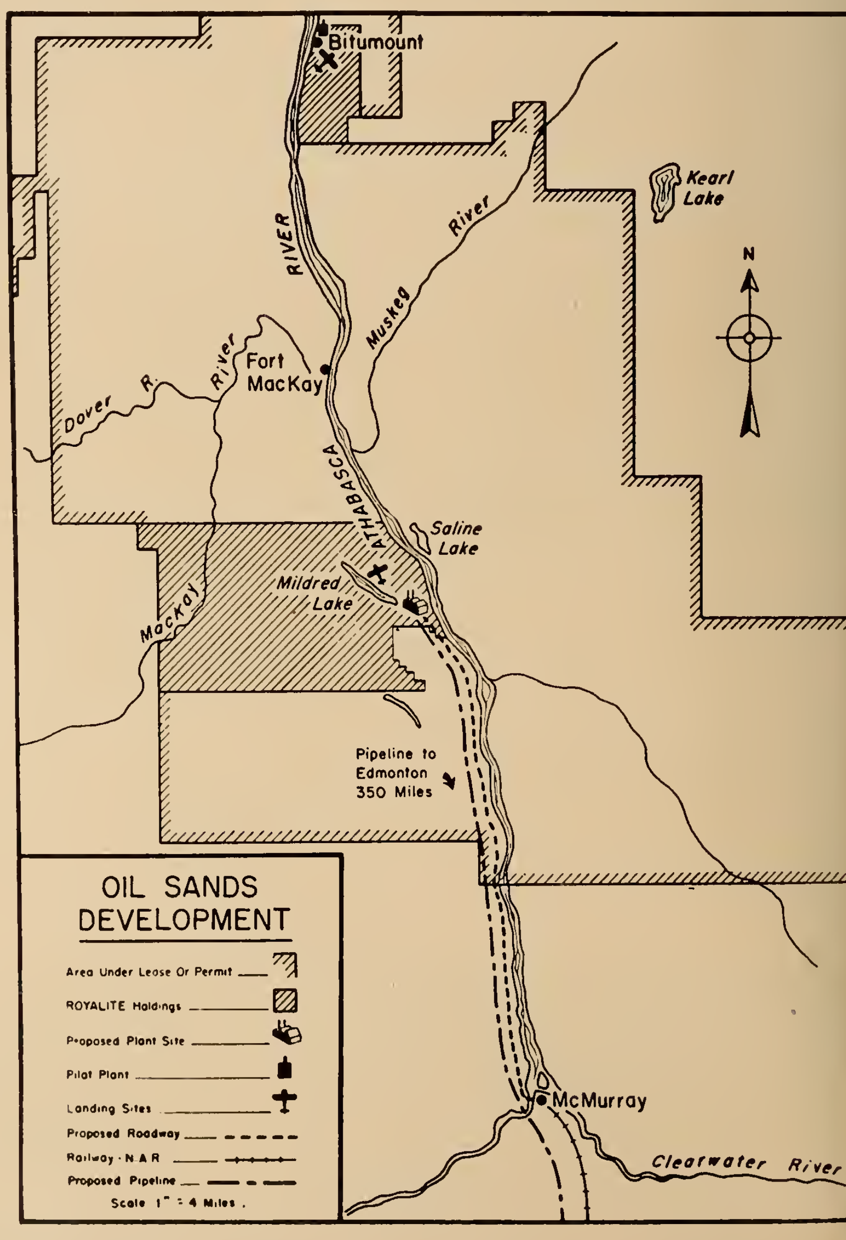
Construction, to begin at spring break-up this year, will be handled by Caribou Engineering Company, Calgary. The greatest part of the work this year will be in engineering and design. In 1958 the processing and separator equipment will be installed. Heavy construction would be concentrated in 1959, with the building of the plant and a 350-mile pipeline to Edmonton. Royalite estimates the entire project will be ready for operation by 1960, having cost a minimum of $50 million.

The Coulson centrifuge process, invented by Gordon Coulson, of Calgary, spins the sand from the oil. The oil sands will be mined and transported to the separation plant. Here banks of giant centrifuges will automatically separate the oil, sand and minute particles of clay. Clean waste sand will be pumped out to the low-lying river bank.

The oil, which is approximately 7° gravity (API) will be transferred to a nearby processing plant to undergo a coking process. It will then be pumped to a sulphur plant which will produce an estimated 140 tons of sulphur per day.

The resulting crude will test 20° to 30° gravity (API), thus permitting normal flow through an oil pipe line. The oil will yield high value products, ranging from premium gasoline to jet and diesel fuel. There will be no waste.

Preliminary engineering and design has been prepared by Pipe Line Technologists of Calgary and Houston.



Bersimis Montreal Microwave Link

Hydro-Quebec's 440-mile microwave link has been completed, the longest private commercial microwave system in Canada. It joins Montreal with Labrieville in northeastern Quebec, site of the Bersimis River hydro-power generating plant.

Other points linked in the 15-station electronic system include Beauharnois, Charlesbourg, Forestville, and the site of the projected Bersimis No. 2 power plant, 18 miles down-river from Bersimis No. 2.

The primary purpose of the $1 million system is to provide communication and control circuits between the Hydro-Quebec offices in Montreal and the Bersimis generating stations and also to provide mobile radio coverage to maintenance crews on the highway along the 330 kv. power transmission line. The system also provides circuits between Montreal and the existing generating station at Beauharnois.

The facilities provided are:

22 voice channels between the main drop points in the system.

2 party line teletype circuits linking these stations.

6 telemetering circuits terminating in Montreal from Beauharnois, Charlesbourg, Bersimis I, and eventually Bersimis II, for automatic remote measurement of conditions.

2 load frequency control circuits originating in Montreal, to allow remote control operation of certain equipment.

The mobile channel ties in to base station equipment at every location except Beauharnois and provides communication from operators at the four control points to mobiles along the route, as well as mobile to mobile communications.

The order wire channel allows party line communication between all stations for maintenance personnel, and, at main locations, for the local operator.

The fault alarm system automatically reports fault conditions from all stations to attended control points at three locations.

Engineering and construction of the system were handled by RCA Victor Company, Ltd., of Montreal. It fills the Hydro's requirements for a number of different voice, teletype, control and mobile facilities in a developing area.

There is other microwave construction under way in Canada. On the west coast a system was recently completed between Vancouver, Burnaby Mountain and Ingledow for B.C. Electric Company. In Alberta a system linking Brooks and Empress is finished, and another linking Edmonton-Valleyview-Peace River and Valleyview-Grand Prairie is being started; both are for the Alberta Government Telephones. In Manitoba RCA has been awarded a contract by the Manitoba Telephone System to connect Swan River and Flin Flon.

Nickel Development In Manitoba

Plans for the development over the next three or four years of a $175 million nickel project in the Mystery-Moak Lake areas in northern Manitoba were announced early in December by Premier Douglas Campbell of Manitoba and President Henry S. Wingate of the International Nickel Co. of Canada Ltd. It will include the opening of two new nickel mines, to be known as the Thompson and the Moak. Production is scheduled for 1960.

Exploration for the new project has lasted ten years and has cost some $10 million to date. When completed, it will constitute the biggest nickel producing operation in the world, next to INCO's operations in the Sudbury district of northern Ontario. Together with the Sudbury development, it will raise INCO's annual nickel producing capacity by 130 million pounds.

As presently planned INCO's investment in Manitoba excluding exploring and pre-production costs will be approximately $15 million. This will include cost of opening and developing the two mines, building concentrator, smelter, refinery, transportation facilities and a townsite for an ultimate population of 15,000.

The amount excludes the cost of a power plant at Grand Rapids on the Nelson River, to be built by the Manitoba Hydro-Electric Board at a cost of between $32 and $35 million. Here 200,000 horse power could be developed. The arrangement reflects the long standing desire of the government to develop the site. Also excluded is the cost of a 30-mile railway branch to be built by the CNR and some $20 million of homes and buildings.

The new town, plant site and adjacent mine will be named Thompson, in honor of Dr. John F. Thompson, board chairman of INCO, who this year completed 50 years of service with the company. The town will be set up as an industrial townsite under the Manitoba laws, and will cost an estimated $20 million.

INCO will assist in financing the power plant by a 4-year 2-per cent loan during the construction period. To get the program under way immediately the company with its own funds will finance all initial capital costs but expects to be reimbursed for its advances for the power plant and any advances made for the railway.

President Wingate said the project would contribute greatly to the much larger supply of nickel which the free world can expect by 1960. But he emphasized that since the Manitoba ores carry much smaller copper values, INCO's copper production capacity will not be increased correspondingly with the large increase for nickel. In view of the cost of separating and refining the copper, the copper content is not regarded as a commercial asset. Minor quantities of cobalt, platinum, palladium, silver and gold are present to assist in making the project successful.

Canadian Pipeline Projects

Westcoast Transmission

Dutton Williams Ltd. had virtually completed section one, extending 120 miles from Peace River to Azouetta Lake by Christmas, thanks to the early exceptionally mild winter break. Without it, most of the men and machines would have had to be retained until spring. A mass exodus for home followed, some on holidays and others leaving permanently, leaving about 35 on the site. Heavy equipment was being marshalled for shipment south to either the Trans Canada pipeline, or for the distribution systems of Inland Natural Gas. The contractors estimate early completion had saved them $50 to $60 thousand.

Though more than 70 per cent of the main line mileage, or 455 miles from Taylor, B.C., to the Fraser valley was thus complete, work was continuing on river crossings, aerial bridges, compressor stations and on the gas scrubbing plant. River Construction Corporation Ltd., had already started laying the 150-mile gathering system in the Peace River area of Alberta and B.C.

Westcoast has contracted to buy 65 million cubic feet of gas per day from Phillips Petroleum in British Columbia. Phillips will supply an additional 150 million feet daily when the demand justifies it. The line will begin next fall to deliver 400 million cubic feet daily.

Savanna Creek Gas for Export

It was announced at year-end that Westcoast had signed a contract with Phillips Petroleum Co. of Bartlesville, Oklahoma, for gas in the Savanna Creek area in southern Alberta, near the British Columbian border. Another contract has been signed with Pacific Northwest Pipeline Corp., the company with which Westcoast has a contract to deliver gas from its Peace River line, for export of Savanna Creek gas to the United States via Kingsgate, B.C.

The program will be divided into two stages. In the first phase, $55 million will be spent to increase capacity of the 30-inch Peace River line from the presently planned 400 million cubic feet daily capacity, to 660 million cubic feet daily, by additional compressor stations and other facilities. Prime user will be Pacific Northwest Pipeline in the U.S., but both B.C. Electric and Inland Natural Gas have also increased their planned volume.

The second phase, costing $45 million, will conclude a 174-mile, 30-inch pipeline from the Savanna Creek field to southeastern B.C. and the U.S. border. Also included is construction of a 500-ton daily sulphur plant in southwestern Alberta.

Pacific Northwest Pipeline completed its main line from the San Juan Basin to the Canadian border early in December. The work involved 1481 miles of main line and 884 miles of laterals and gathering lines.

Inland Natural Gas had completed its survey for their main line through the interior of B.C. by mid-December. A start on pipe laying is planned for February. The work will include 304 miles of main and 73 miles of laterals and feeder lines, as well as distribution systems. Three spreads will operate; — one between Kamloops and Kelowna and between Kelowna and Penticton, a second between Penticton and Kootenay and a third between Okanagan and Nelson. Dutton Williams Ltd. has been awarded the contract for the work.

Premier W. A. C. Bennett of British Columbia announced in December that the B.C. government plans to establish one of the most modern and competent petroleum and natural gas divisions on the North American continent. The announcement was made at the annual meeting of the Canadian Petroleum Association.

Trans Canada Pipelines

A severe prairie blizzard on December 9/10 just about called a complete halt to further clearing. On section 3, Universal Pipeline Ltd. had completed clearing the right of way by mid-December, but lack of pipe for installing the road crossings made further work impossible. On section 4, Dutton Williams Ltd. was continuing with clearing but had stopped grading and stringing. On section 5, Price-Poole Ltd. had closed down early in December. Canadian Bechtel Ltd. on section 6 had cleared 26 miles as far as the Assiniboine crossing near Portage la Prairie, and though no grading was possible some clearing was continuing.

Though survey crews were still working on section 7 east of the Red River, no contract award had been announced. There was little progress to report from the Bechtel Ltd. double jointing yard, though some ten miles of pipe had been delivered at Portage la Prairie siding. The first section of the river crossing at Portage la Prairie was completed on December 17. This was the first of two 560-feet sections to be laid in the river. The second section would be completed after Christmas, weather permitting. Another major river crossing is at Miniota, where work was nearing completion.

Trans Canada had until February 1, 1957 to prove financial ability to build its line. This, the third hoist for the deadline, was granted by the Board of Transport Commissioners on November 1. Because the U.S. midwestern market for Canadian gas was not now available, the financing had been rearranged to provide for a deficit for the first three to five years of operation.

Dominion Natural Gas Co., of Brantford, Ont., is planning a $2½-million expansion program for 1957, double the company's 1956 program which included acquisition of the properties of the Port Colborne Welland Gas Co. The company brought in 29 new producing wells in 1956.

Consumer's Gas Company of Toronto

President A. L. Bishop of Consumer's Gas Co. of Toronto, told the Company's annual meeting in November, that the Company continued to experience an appreciable gain in sales last year from the addition of commercial, residential and industrial load, both on Consumer's Gas and Provincial Gas systems.

The company's annual report for year ending September 30, 1956, showed natural gas deliveries of over 9 billion cubic feet, as compared with 4,878,617,000 cubic feet the previous year and 3,831,450,000 cubic feet the last year manufactured gas was sold. Net income amounted to 82 cents per common share, compared with 66 cents the previous year.

Union Gas to Expand Services

With arrangements now completed for large, long-term volumes of natural gas, Union Gas Co. of Chatham now plans a program for construction of pipelines and other facilities to carry this gas to waiting markets. It will represent the largest single expansion program in the company's history.

Preliminary engineering plans are completed and work has been under way for some time on other preliminary phases such as obtaining franchises and contacting landowners regarding right-of-way. Orders are placed for all the necessary pipe and some of the smaller sizes are already being delivered.

However, completion of the project depends on how soon pipe mills can deliver the 140 miles of large diameter pipe required for the main line. The company hopes to complete the line from its underground storage area in Lambton County to the vicinity of Hamilton by the fall of 1957.

Automobile-Passenger Ferry

At high tide in November 29, the automobile-passenger ferry "Lord Selkirk" was launched at Pictou, N.S. The $2,000,000 vessel will ply between Cariboo, Nova Scotia and Wood Islands, Prince Edward Island.

The Cariboo-Wood Island route is part of the Trans Canada Highway system and the ship has been constructed to specifications. It is a double-ended ferry — a drive-through type to reduce loading and unloading time. It is 260 feet long, 52 feet wide and will have a service speed of 12 knots.

The main deck will handle a capacity of 60 automobiles or other vehicles in five lanes and accommodation is provided for 300 passengers. Four propellers (two forward and two aft) are designed so that the pitch of the blades may be changed while the ship is in operation. This will permit ease in maneuvring.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE
ELECTIONS AND TRANSFERS

Expansion of Institute Technical Activities

This report has been prepared by the chairman of the Institute's Committee on Technical Operations, F. L. Lawton. Members are urged to read it in order to satisfy themselves that the Institute is prepared to expand greatly its interest in the development of technical studies and activities. Mr. Lawton is writing to all branches to solicit their support in the set-up of committees. It is hoped that the membership will support the committee in the huge task which they have assumed under Council's direction.

The Editor

Report of Committee on Technical Operations

At the annual meeting of Council on May 22, 1956, after lengthy prior consideration, Council adopted the report of its special Committee on Technical Operations.

This report was as follows:—

"Council, at its meeting in Hamilton on February 26, 1955 adopted a report which recommended the setting up of a Committee on Technical Operations, which was duly appointed, with the following scope or terms of reference:—

(a) Keep all technical activities of the Institute under constant review.

(b) Recommend to Council the establishment of such subcommittees of the Committee on Technical Operations as necessary to carry out reviews of specific fields of technical activity and also such special or standing committees of the Institute as may appear warranted by developing needs, in technical areas.

(c) Recommend to the Papers Committee a particular subject or field of endeavour which should be treated in a paper or papers.

(d) Recommend to the Publications Committee particular papers for publication.

(e) Report quarterly to Council on technical activities of the Institute.

(f) Do such work as desirable to encourage the formation of technical sections in the branches.

This report deals with that section of the scope relating to (f) — "Do such work as desirable to encourage the formation of technical sections in the branches".

Need for Improvement

Many members of the Institute, from one end of Canada to the other, recognize that now, as never before, there is a real need to undertake constructive work to improve the technical activities of the Institute, in order to achieve, on the scale necessary, our basic objectives, which are:—"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interest, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

Why is there this need? The answer is embraced in the following observations:

1. Canada is experiencing a period of rapid growth, with a substantial influx of new Canadian engineers into Canada and into the Institute. If the Institute does not provide the means whereby the professional needs of these new members are adequately met by the calibre and scope of technical activities of the Institute they will turn elsewhere.
2. For some time there has been a greatly increased tendency to go outside Canada for consultants whenever major industrial and other undertakings are being planned.
3. There has long been a tendency for many Canadian engineers to look to the professional societies in specialized fields in the U.S.A.

Cover Picture

A stage in the manufacture of the transatlantic telephone cable (page 144 of this issue). The picture shows adjustments being made to the machine which applies to the insulated conductor simultaneously, the copper return tapes and the jute bedding for the armouring wires.

Photo courtesy Submarine Cables Limited which with large memberships, have tended to splintering the profession in Canada.

4. Lack of adequate and well-organized provision for technical activities in the Institute has resulted in many excellent presentations of Canadian engineering achievements being initially presented before U.S.A. societies, to the detriment of the Canadian engineering literature as well as the Institute and the long-range interests of Canadian engineers.

5. Canada's growing industrial stature and prestige abroad both require the development of the strongest possible technical recognition, which can be achieved by the creation of a distinctive Canadian engineering literature.

The Institute has done much in the field of technical activities but there is a wealth of opportunities to do more, thus serving the members of the Institute and Canada. How can this be done?

Certain branches have shown how this can be accomplished. For instance, Winnipeg Branch has a strong Electrical Section. Montreal Branch, for several years, has had a number of technical sections, which have gradually assumed greater significance than the traditional meetings, insofar as diversified membership interest and participation are concerned.

Your Committee on Technical Operations in a report to Council under date of March 26, 1956, has recommended certain action relative to technical activities on the nation-wide Institute level.

Four Recommendations

Your Committee now recommends, further, measures concerned with the encouragement of technical activities in the Branches. These recommendations are:—

1. That, in the proposals embodied in the report of March 26, 1956, the words "subcommittee" and "Subcommittees" be replaced by the words "Division" and "Divisions" respectively.

2. That there be added to the scope of Divisions of the Committee on Technical Operations a sentence reading "The Division on . . . Engineering shall encourage the formation of Technical Sections dealing with its area of engineering in the Branches, assist such Technical Sections in their work, and coordinate activities of such Technical Sections in the various Branches."

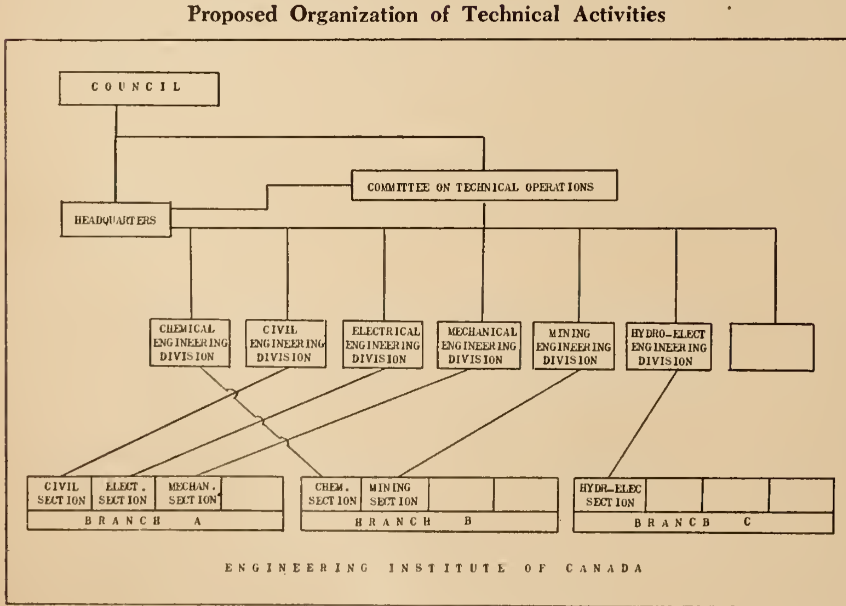
3. That, in pursuance of (2) above, each Division of the Committee on Technical Operations shall:—
   (a) Encourage the formation of branch technical sections by presentation to branch executive committees of data on procedures found to be effective by branches with successful technical sections and on results achieved thereby.
   (b) Make available to branch technical sections up-to-date lists of speakers (and their subjects) who can be secured in the various fields of engineering activities.
   (c) Co-ordinate and make available to branch technical sections the practices and experiences of the various branch technical sections within the scope of a division.
   (d) Promote the preparation and presentation of papers on technical subjects by branch members.

4. That there be a member of the Headquarters staff who shall act as secretary of the Committee on Technical Operations and as secretary of the several Divisions of the Committee on Technical Operations.

The above report was the result of long deliberation by the special Committee on Technical Operations. These deliberations were directed towards achievement of the technical aims expressed in the by-laws.

Your Council is desirous of enhancing the calibre of the technical activities of the Institute, both at the national and branch levels, with the dual aim of widening the scope and improving the quality of technical activities in the branches, thus developing an engineering literature of distinctly Canadian character and of the highest quality.

Proposed Organization of Technical Activities



Experience of Other Societies

The character of the development which it is hoped to achieve is similar to that which has been accomplished by sister societies in the United States, exemplified by the divisional organization of the American Society of Mechanical Engineers and the American Society of Civil Engineers. These two societies entrust the promotion and control of technical activities within the several divisions of interest to their respective divisional organizations. The American Institute of Electrical Engineers has had for some years a somewhat similar divisional setup which has now been extended by the transformation of the former committee responsible for technical operations into the Technical Operations Department. This is operated by appointed members working on a purely voluntary basis. The results have been outstanding. One of the principal objectives is to promote liaison between the technical groups in the various Sections (Branches), and the national technical committees.

As the diagram showing proposed organizations of technical activities indicates, your Committee on Technical Operations initially plans only six divisions, but this may be added to any time as needs arise.

The Committee consists of the following members: B. G. Ballard, Ottawa, C. E. Frost, Montreal, R. M. Hardy, Edmonton, A. R. Harrington, Halifax, W. H. Paterson, Toronto, D. L. Rigsby, Kingston, S. Sillitoe, Belleville, E. R. Smallhorn Montreal, F. L. Lawton, Chairman, Montreal.

You will be hearing more about the plans of your Committee on Technical Operations in the future through the medium of the *Journal*. This is an initial progress report.

Hydraulic Engineering

The Netherlands Universities Foundation for International Cooperation will offer to graduates in engineering from all parts of the world, starting in October 1957, an "International Course in Hydraulic Engineering".

There is an expectation on the part of the Delft Technological University and the Foundation, jointly initiating the course, of a favourable response. They plan to offer a well organized and responsible scientific treatment. There is also good opportunity for visual illustration in the vast hydraulic engineering projects now under construction or planned.

The course will start on Tuesday, October 22, 1957, and will last for a twelve-month period with four intervals for holidays. Instruction will be in the English language.

There is a copy of the prospectus of the course in the Library of The Engineering Institute. This gives information about requirements for admission, the award of a diploma in hydraulic engineering, fees and expenses, fellowships, and the particular subjects of courses. More complete information can be obtained from the Netherlands Universities Foundation for International Cooperation, 27 Molenstratt, The Hague, The Netherlands.

Correspondence

A New Member Writes

Dear Dr. Wright,

Thank you very much for your letter of December 13 advising of my election as a member of the Institute and particularly for the very warm welcome expressed by you.

I count it as a great privilege to be numbered with those who already are members and, while I hope and believe that there are many advantages accruing to myself, I trust that I may be able to contribute something, however small, to the growing body of Canadian engineers and engineering.

R. Douglas Mutch, m.e.i.c.

Montreal.

Value of Membership

Dear Dr. Wright:

I am in receipt of your letter and wish to say that it inspired me sufficiently so that I now plan to begin catching up on past dues and maintain my membership in the Institute. Originally I felt that I resided too far from Canada or any Institute branch to make it worthwhile. But after thinking about it and realizing that the engineering profession has given me my share of personal satisfaction plus worldly goods, I now believe the Engineering Institute of Canada should be supported by all those who have benefitted or might benefit from it.

I came to the Boston area in 1951 by virtue of an ad I ran in the *Journal* for employment, which was answered by a well known Boston engineering company. Without that service I might be still running a transit for a department of highways.

I hope you do not feel that I am speaking disparagingly of those noble fellows who get the road construction done, but if an individual feels he can improve both his personal and professional standing by going into some other branch of engineering, such as structural design for example, which I am now practising, he may never be happy unless he does. Everyone to his own liking, but he who is dissatisfied and knows he can do better should make a move, and being an Institute member may be a big help.

Thank you for not having my name removed. I was very much relieved when I saw in your letter that you had not at that time presented it for removal.

m.e.i.c., Massachusetts.

Sanitary Engineers
(Is it necessary to advertise the fact)

To the Editor,

A short time ago a prominent B.C. newspaper headed an article with "Sanitary Inspectors go to Winnipeg". The men mentioned were to attend the National Convention of Sanitary Inspectors. I find that there are a number of professional engineers calling themselves Sanitary Engineers, also a number of towns have in their list of officers a "Sanitary Engineer".

That these men are sanitary must be a great advantage at a crowded meeting. This unfortunate nomenclature also became prevalent in England and a recent cutting from one of their papers read as follows:

> "LONDON — Sanitary inspectors will in future be known in Britain as 'public health inspectors' because they strongly object to their present name."

The joke that one bath per month was the qualification for an Associate and two for full membership proved too much for them.

Sanitation is the devising and application of means for the improvement of sanitary conditions. Hence sanitate: to put in a sanitary condition.

In my opinion these men should be called *Sanitation Engineers and Inspectors.*

The sloppy nomenclature in using the word "sanitary" instead of "sanitation" should not, I think, be tolerated by a professional body.

Perhaps our Sanitary Engineers exercise the same privilege as Her Majesty in giving the "Order of the Bath" to its members.

A. J. Gayfer, m.e.i.c.

Professional Engineer (Alta.) (Retired) also Sanitary.

The Index, 1956

Reprints have been made of the Index of *The Engineering Journal* for the year 1956, which appeared in the January issue, and copies are available from the Institute Library.

Elections and Transfers

At a meeting of Council held at Montreal on January 26, 1957, a number of applications were presented for consideration and on the recommendation of the Admissions Committee, the following elections and transfers were effected:

MEMBERS

R. L. J. Beccat, Montreal; J. A. Boa, Montreal; D. A. Burnett, Rossland, B.C.; P. T. Christoffersen, Vancouver; C. R. Crocker, Ottawa; R. E. Diefenbach, Montreal; E. E. Embacher, Hamilton; R. A. Hanright, St. Catharines; J. L. Haydock, Niagara Falls; J. R. K. Hickman, Peterborough; R. F. Hooley, Vancouver; H. B. Johnson, Toronto; B. Justewicz, Montreal; C. E. King, Corner Brook; E. Kuhi, Montreal; J. G. Livland, Vancouver; U. Matiss, Ottawa; O. Meyer, Quebec; H. N. Muller, Hamilton; W. C. Pietz, Toronto; A. G. Roberts, Toronto; J. C. Robinson, Edmonton; P. D. Rossiter, Montreal; K. Slesers, Sarnia; D. A. Sloan, Montreal; P. S. Smith, London; J. W. Thomson, Toronto; D. D. Urquhart, London; W. E. Van Steenburgh, Ottawa; A. R. Walker, Toronto; G. L. Wilson, Sudbury; W. B. Workman, North Bay; M. S. Yolles, Toronto; J. M. Zarzycki, Ottawa; G. R. Zethner, Toronto.

JUNIORS

G. C. Bellamy, North Bay; P. G. Jones, Maitland; R. J. Lapum, Ottawa; R. W. Lowe, Montreal; C. F. Smale, Ottawa; P. G. Stein, Toronto; J. Weatherall, Kingston.

JUNIOR TO MEMBER

C. M. Armstrong, Windsor; L. F. Bresolin, Toronto; E. H. Lambert, Toronto; D. K. Lawson, Toronto; M. Lupu, Montreal; G. J. O'Sullivan, Toronto; J. G. Ouellette, Montreal; J. N. Pritchard, Ottawa; D. Quan, Toronto; D. M. Ripley, Montreal; R. F. Routledge, Sarnia; J. E. Rymes, Fort William; R. J. Sheridan, Toronto; A. T. Sherrett, Dryden; G. C. Simpson, Montreal; H. C. Sylvia, Montreal.

STUDENT TO MEMBER

M. F. Oster, Toronto.

STUDENT TO JUNIOR

G. J. T. North, Sarnia.

STUDENTS ADMITTED:

University of Manitoba

G. D. Balacko, H. J. Berry, R. P. Bukata, L. L. Charriere, R. Diamond, G. B. Dyer, P. J. Fulford, F. S. Gira, F. H. Gunston, L. P. Haberman, R. J. Herbertson, R. C. Isaak, D. K. Johnson, D. A. Kasianchuk, D. W. Klemm, T. W. Klym, W. Kudryk, E. E. Lach, C. A. L. L'Ami, B. K. Laxdal, A. Leung, D. N. Maclean, G. O. Martens, R. E. Moyne, F. G. Metcalfe, W. F. Miller, A. D. Myska, M. W. Nastuny, G. A. Nuttall, J. G. Pashniak, S. J. Plante, W. M. Potolicki, I. G. Purves, R. K. Rendall, F. E. Roy, N. J. Slobodzian, R. G. Strachan, L. B. Sylvester, R. H. P. Thom, J. E. Thomlinson, J. C. R. Thomson, B. C. Walker, D. F. Whalley.

University of Sherbrooke

L. Bruneau, J. L. Cloutier, P. Cote, A. Y. Donaldson, P. R. Fortier, P. G. Gagne, J. H. R. Gagne, Marc Gagnon, Marcel Gagnon, J. P. Gosselin, M. Gratton, J. Y. Grimard, J. G. Grondin, R. Gonthier, N. Goyette, S. Grenier, C. H. Haman, A. Hamel, R. Hamel, G. Labonte, L. Lamoureux, R. Le Blanc, M. Perron, M. B. Pinard, J. N. Roy, J. Roy, R. Royer, R. Vallee.

Carleton College

R. A. Baird, I. C. Boyd, A. R. Campbell, J. S. Fraser, C. R. Guile, C. E. Hanlan, E. R. Jenkins, G. C. Langdon, E. B. Morrison, R. E. M. Nourse, E. T. O'Brien, R. M. Rowan, R. M. Scott, D. R. H. Spence, G. A. Suek.

Queen's University

A. E. Collver, J. W. Coyle, D. A. Croft, P. M. Gillhorn, E. J. Hope, J. E. Little, N. M. MacIntosh, K. A. McKessock, A. J. Percy, A. A. Purvis, F. A. Skanes.

University of Alberta

T. J. J. Bartkiewicz, M. B. Bayer, R. E. Bolter, R. E. Graham, W. R. Lee, G. R. McDonagh, D. J. McPhee, J. J. Rolston, D. W. Ferrier.

University of New Brunswick

E. F. Carpenter, C. F. Edgecombe, H. H. MacLennan, H. A. Noble, L. V. Rankin, J. B. Robinson, K. N. Tomilson, S. L. N. Vennos.

University of Toronto

R. S. Broughton, P. J. Brunner, R. R. Cole, P. N. Gryniewski, M. J. Heuer, R. S. Osmaston

McGill University

Y. A. Conan, A. P. B. Folkes, J. G. Komaroff, P. W. Baird.

Dalhousie University

A. J. D. MacKinnon, P. Poot.

Mount Allison University

R. B. Smith, M. P. Mills, S. W. Balch, E. A. Maxwell.

Laval University: A. De Blois.
McMaster University: L. M. J. Bacquie.
Ecole Polytechnique: B. Bouchard.
City & Guilds Certificate: J. Mobley.
M. Fraser, B.Sc., (Mech.), 1956, Univ. of Sask.; R. M. Allan, B.Sc. (Civil), 1956, Queen's Univ.

Applications through Associations of Professional Engineers

ALBERTA

MEMBER: T. R. Gunther, R. J. Pospischil.
JUNIOR: R. P. Albright.
JUNIOR TO MEMBER: J. S. Harris.
STUDENT TO MEMBER: E. L. Taylor.

SASKATCHEWAN

MEMBERS

H. A. Clampitt, J. A. Crate, J. E. Edmunds, G. J. Lindsey, W. B. McCoy, G. T. Peters, I. Spector.

JUNIORS

H. Lee, G. B. Nenson, M. M. Muth.

STUDENTS

R. J. Baron, J. W. Chepyha, S. D. Curran, S. A. Dencsak, R. A. Doull, W. J. Frier, G. J. Funke, A. W. Gunter, B. H. Hamilton, C. M. Hansen, O. W. Hanson, T. D. Harris, P. Kitzan, L. L. S. Larson, C. S. Lines, N. A. MacKenzie, G. M. McMahon, A. M. Norlander, J. H. Peterson, B. G. Pratt, G. E. Prince, D. P. Rauch, A. G. Staflund, V. N. Tomaschuk, P. R. Ukrainetz.

JUNIOR TO MEMBER: M. Kissel, E. Staible, L. F. Toth, F. G. Ursel.

MANITOBA

MEMBER: L. P. Kaegi.

NOVA SCOTIA

MEMBER: F. G. Curry, D. B. Dorey, B. V. McDonald.
JUNIOR TO MEMBER: J. Allan, W. E. MacDonald, C. J. McManus.

Testing Penstock Welds at Trenche Development, June, 1955. This photograph, contributed by The Shawinigan Water and Power Company, Montreal, received an award of merit in the E.I.C. photographic exhibit, 1956.

THIRTY-FIVE YEARS AGO

Comment on the Journal of February, 1922

They say that anything can be proved by a judicious juggling of statistics. Fortunately, we do not wish to prove anything in analyzing the Institute's position in December 31, 1921, reported in the *Journal* for February 1922, and its position on December 31, 1955, thirty-four years later: because these notes are necessarily written some months in advance of their publication, we cannot wait for the results of 1956's operations. We are interested only in interesting points which may be brought out by a comparison of the two sets of data.

Let us look at the state of the Institute's finances, first as to totals. In 1921 income was $47,497.53 and expenditure was $37,183.80, leaving a favourable balance of $10,313.73. The corresponding figures for 1955 were $496,820.23, $437,839.67 and $58,980.56. In 1921 the Institute had $335.50 invested in revenue producing securities; in 1955, this figure had risen to the very respectable sum of $192,375.80, including $20,644.19 held in trust for various medal funds and the like. Our total assets increased during this period from $115,088.55 to $292,708.10.

One excellent reason for accumulating a surplus is that before too many years the natural growth of the Institute is going to compel it to find larger headquarters. Anybody familiar with the anthill conditions in our present offices will readily grant that conclusion. When the time comes for expansion, its financing will be immensely easier if we can assume a substantial proportion of it ourselves, no matter whether we put up a new building for our own exclusive use, build one for joint occupancy with some of our sister societies, or arrange for a long lease of space in some commercial structure. And, of course, the income from invested surplus, $4,152.35 in 1955—could be used to pay for something we would otherwise feel we could not afford.

Getting back to the balance sheets we are comparing, let us look at a few selected items. Members' fees, excluding arrears, rose from $34,267.29 in 1921 to $186,380.82. More interesting figures — arrears dropped from about fourteen per cent of the total billed in 1921 to about four per cent in 1955, partly a reflection of economic conditions, we imagine, though perhaps our financial wizards are tougher now than they used to be.

In 1921 the *Journal* produced a net revenue of $6,204.89; in 1955, the comparable figure for the *Journal* and Directory was $38,239.40, not at all a bad record, reflecting the position the *Journal* has attained as that of the leading Canadian engineering periodical.

Financial statistics are notoriously dull for anybody except those directly responsible for them, so let us look at membership figures. At the end of 1921 there were 4,879 members of all grades, of whom 899 were students and 3,980 of higher grade. At the end of 1955, the Institute had 2,630 students, and 13,440 members of higher grade, a total of 16,070.

In themselves, such figures do not mean much. One would expect our membership to increase with Canada's population and with the rising proportion of engineers in it. The question is "are we keeping up with the procession?" R.DeL.F.

WORLD POWER CONFERENCE

The Transactions of the Fifth World Power Conference held in Vienna in June, 1956, will be published shortly. The theme of the Conference was "World energy resources in the light of recent technical and economic developments" and the twenty volumes of the Transactions contain, in either German, French or English, according to the choice of the author, all the 276 papers presented. They may be ordered from the Canadian Committee of the World Power Conference, T. M. Patterson, M.E.I.C., Room 500, 150 Wellington Street, Ottawa 4, Ont. The prepublication price is 3500 Austrian sch. (approximately $135.00) plus carriage. The price after publication is 3700 Austrian sch. plus carriage. In either case a discount of 20% is allowed when the order is placed through the National Committee.

Irving R. Tait retired from Canadian Industries Limited in December 1956. Here he is shown at a reception, receiving a gift camera from H. Greville Smith, C-I-L president. Left to right: T. W. Smith, formerly of C-I-L, Mr. Smith, Mr. Tait, former chief engineer, H. W. Umphrey, present chief engineer, and W. T. D. Ross, C-I-L vice-president. Mr. Tait is a past vice- president of the Institute, a past chairman of the Finance Committee, and currently a member of the Committee on Professional Interests.

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

QUEBEC

"On This Matter of Shortage"

Taken from the Bulletin of the Corporation of Professional Engineers of Quebec, December 1956. This article is an excerpt from a speech delivered by the president of the Corporation, Leo Roy, M.E.I.C., *before the members of the Lake St. John Region at a meeting held in Chicoutimi on October 4, 1956.*

"For some time now, you have heard about the shortage of engineers attributable to the extraordinary industrial boom of our country in general, to say nothing of the present expansion in the province of Quebec in particular. But how long is this shortage of engineers going to last? This is an extremely important and serious question which confronts the profession.

Not that the number of engineers we train in this country is negligible; on the contrary, the number of engineering graduates has been growing considerably year after year. Our neighbors to the south have recorded a similar increase — the number of engineers as compared with labour has soared from a ratio of 1 to 140 in 1940 to a ratio of 1 to 80 today.

At home as well as in the U.S.A., the number of engineers has grown more rapidly than that of labour and the demand for engineers in industry has skyrocketed. Today, the needs in this field are far from satisfied.

However, the situation is not without remedy, provided we manage to take more advantage of some technical talents now being squandered in jobs that are not connected with the engineering profession as such.

Nevertheless, I feel that if we worry about the actual shortage of engineers today we should not worry too much about the future shortage of engineers. Being naturally inclined to optimism, I agree with Financial Post editor Michael Barkway, who said: For practical purpose the next five years count more, there will definitely be a serious shortage and these years will count more than perhaps the next ten. By 1960, we shall have in Canada about a quarter of a million more children between 15 and 19. Probably a larger proportion of them will also be going to university. You can then assume a sharp increase in the supply of engineers from 1961 on. Hang on for another five years, and the worst of our troubles should be over.

And it suggests a word of warning to the young. Shortage in the next few years and the high rates of pay which it causes could go on tempting an increasing proportion of lads to take engineering courses.

So it is by no means impossible that engineers might be in over supply in the 1960's.

It would be a very short-sighted policy on the part of our youth to envisage the problem with only remuneration in view. The real problem is that of training engineers so as to satisfy the demand and to keep abreast of the expanding Canadian industry . . . ."

Members Opinions

It is understood that the opinions expressed hereunder are personal and are not necessarily those of the Corporation.

Considering the importance of our feature article on the utilization of engineers, we canvassed several members of the Corporation with a view to presenting their opinions for consideration. While we found that there was no shortage of opinion, there was an unwillingness to be quoted directly. Most of the members approached felt that any shortage or surplus of engineers was tied so tightly to the national economy that it was necessary to make assumptions regarding this which might prove untenable.

Assuming that our present expanding economy continues, all members agreed that there was a shortage of engineers. There was not such a unanimous agreement on the reasons for the shortage. It is generally agreed that an engineering training prepares a man for many fields of endeavor and that several graduates from our universities take advantage of this training to advance on other lines. There was no criticism levelled at this, although there was some made about graduates who emigrate immediately after graduation, to the United States. One unique opinion was that since the country had invested a great deal of money in giving engineering students their education, these students should enter into a committment to work for five years in this country, or for a Canadian company abroad.

One prominent Montreal engineer suggested that the graduates of recent years do not have the competence nor do they acquire the wide experience of earlier engineers. He felt that it now takes three engineers to do the work that two were doing twenty years ago. This engineer also made a point that was repeated several times by other members; that is that engineers are being used in great numbers for jobs requiring nothing more than competent technicians. In this category he would put engineers employed as draftsmen, checking off material, doing routine testing, or any other occupation which merely necessitated collecting facts without having either to analyze them or to apply them.

Amongst younger engineers there was a feeling that a lack of recognition was driving them away from the field of straight engineering. In general these engineers hoped to stay in the same company but to transfer from an engineering department to a commercial one. The lack of recognition was basically a complaint about salaries, although as one design engineer put it, "Last week one of our sales engineers got a very good order. He was congratulated and shared in the dinner which was held to celebrate the event. He not only had a good time and was made to feel more important but he had the opportunity of meeting our company executives at a social gathering." He then brought up the part that hurt. "We worked hard to solve the problems connected with the piece of equipment. It was our design which made it practical and economical, yet we received no recognition at all."

The role of "sales engineer" was criticized by several members as using up available talent and returning little. It was felt that at the present time there is a great incentive to buy only on price. Some said that under these conditions a company could send a tender to a customer by means of the office boy since technical considerations only too often got little consideration. Some of the sales engineers interviewed felt frustrated under these conditions. Most however were ambitious and recognized that the chances for promotion were greater in the commercial departments. This ambition then kept them on the sales side although they had little opportunity to apply their training, and it was this same ambition which attracted good designers as referred to above, to break from pure engineering. The greatest cynicism came from one engineer who gave the definition of a sales engineer as a "person who engineers a sale." He went on to suggest that if all the drug manufacturing companies employed a large number of doctors on their staff to sell to hospital and retail outlets, there would be a grea hue and cry about the wastage of doctors. He also doubted that a term such as "sales doctor" would be acceptable to the Medical Association.

Summarizing therefore, the general opinion was that there is no shortage of people with engineering training, but there is a very real shortage of people doing engineering work. This has been brought about by the fact that pure engineering does not appear to be an attractive lifetime occupation from either the social or financial point of view in the eyes of the engineers whose opinions were sought.

Persons with a different opinion wishing to express other views on the subject were invited to contact the Association of Professional Engineers of Quebec.

ONTARIO

Engineers in The News

M. A. Elson, has resigned as deputy minister of the Ontario Department of Highways to rejoin the Russell Construction Ltd., Toronto, as a director and executive vice-president of that company.

Mr. Elson, who graduated in civil engineering from the University of Toronto in 1933, was appointed deputy minister of Ontario Highways in 1954 and during his tenure of that office has played an important role in effecting important changes in the department's organization.

Mr. Elson has spent a number of years of his career in the consultation field. During World War II he served with the R.C.E. and in 1945 was in command of the R.C.E. of the Canadian Army overseas. His service included anti-invasion defence work in England, tunnelling in Gibraltar, and field action in France, Belgium and Holland

Following his retirement from the Army he was assistant project manager for the Carter, McNamara, Mannis, Morrison and Knudsen companies (CMMK) in the Quebec-Labrador iron field development. Just prior to his Highways appointment Mr. Elson was general superintendent of construction of the Russell Construction Co. Ltd.

Dr. W. P. Dobson of Toronto has left Canada for a trip to the United Kingdom and India and was one of two Canadian delegates representing the Government of Canada and the Canadian Standards Association at the Commonwealth Standards Conference which took place at New Delhi, India, from January 21 to February 3, 1957. The other Canadian delegate is J. S. Cameron, of Montreal, president of C.S.A.

The conference will deal with standards for materials and equipment with the object of promoting uniform standards in the Commonwealth.

For many years director of the research laboratories of Ontario Hydro, and now chairman of the administrative board of CSA Testing Laboratories, Dr. Dobson is planning to visit several of the atomic energy establishments in the British Isles. His program also includes a visit to K.E.M.A. Laboratories in Arnheim, Holland, which carries on the test work for C.S.A. on the continent

J. H. Fox Elected

New president of the Association of Professional Engineers of Ontario is John H. Fox, vice-president in charge of sales for Honeywell Controls Limited.

J. H. Fox, O.B.E., M.E.I.C.

As president, Mr. Fox will head the largest association of its kind in Canada and the licensing body for Ontario's engineering profession.

A graduate, in mechanical engineering, of the University of Toronto, class of 1927, and a native of Toronto, he has been associated with Honeywell since 1935 when he joined the company as a sales and application engineer on electric and pneumatic controls and systems for heating, refrigeration and air conditioning. His appointment followed employment as a demonstrator in hydraulics at the University of Toronto and as an engineer with a firm designing steam heating systems and plants for all types of buildings.

Mr. Fox has had a distinguished military as well as business career. He joined the R.C.E.M.E. shortly after the outbreak of war and held various staff and unit command appointments while serving in Britain and Northwest Europe. He ended the war as a colonel.

His military service earned for him the O.B.E.

Returning to Honeywell at the end of the war, he was promoted to sales manager of the commercial controls division and from 1951 until his appointment as vice-president last September he was successively manager central division and general sales manager.

His professional memberships include the Engineering Institute of Canada, an associate membership in the Institute of Mechanical Engineering, London, Eng. He is a member of the Council of the American Society of Heating and Air Conditioning Engineers and a past president of the Ontario Chapter of that organization. He is also a member of the Canadian Construction Association.

William J. Fulton of Toronto, has been appointed Deputy Minister of the Department of Highways of Ontario.

Mr. Fulton has been with the Department for 35 years, joining it a short time after his graduation in civil engineering from the University of Toronto.

During his service with Ontario Highways Mr. Fulton has held a number of posts of engineering responsibility. Latterly he has been head of the planning and design department and directed the compilation of a master plan for Ontario highway development for the next twenty years.

Also announced by the Minister of Highways, the Hon. James Allan, was the appointment of John Walter to succeed Mr. Fulton as head of planning and design, and of Hugh W. Adcock, as manager of operation under the chief engineer, W. A. Clarke.

Peter R. Pettit has returned to Australia, where he plans to continue his professional work. He is now living in Mosman, N.S.W. Australia.

Mr. Pettit graduated in civil engineering from the University of Sydney, Australia, in 1950. Coming to Canada some three or four years ago he was first employed as assistant to the superintendent of construction at the University of Toronto. More latterly he has been with the Toronto firm of consultants, Morrison, Hershfield, Millman and Huggins.

A. S. Williamson was recently appointed to the position of town engineer and works manager of the town of Dundas, Ont. Before this appointment he was employed by MacKay & MacKay, engineers and surveyors, in Hamilton.

Everett B. Allen has left Beaucage Mines Ltd., of North Bay, Ont., and is an assistant research fellow at the Ontario Research Foundation in Toronto.

Robert D. Burns is assistant geologist at Geco Mines Ltd., Manitouwadge, Ont.

John G. Gill of Canadian Steel Improvement Ltd., Long Branch, Toronto, has been appointed a director and vice-president in charge of operations of the Company.

Milton M. Hamburger is employed by E. S. & A Robinson (Canada) Ltd., in Toronto. He was earlier with Courtalds (Canada) Ltd.

Robert B. Allison is county engineer for the County of Prince Edward and has his headquarters in Picton, Ont. A graduate in engineering from Queen's University, Kingston, he was formerly assistant distict municipal engineer with the Ontario Department of Highways at

(Continued on page 178)

Chatham, Ont.

R. W. Lewkowitz has moved from Toronto, where he was with Powertronic Equipment, Ltd., and is now living in St. Catharines, Ont. He is employed as a design engineer with Packard Electric Co. Ltd., of that city.

Edward J. Adams, formerly with John Inglis Co. Ltd., in Toronto, is now a design engineer in the civilian atomic power department of the Canadian General Electric Co. Ltd., at Peterborough, Ont.

MANITOBA

Association's Fall Frolic

A capacity crowd turned out for the first Fall Frolic held by the Association. Members violating the rules of the dance floor were arrested and tried by the judge, who was complete with gown and wig. If found guilty offenders were placed in a small "jail" to remain there until fines were paid.

Jack Hoogstraten, the Association president was awarded the prize for design. This was a pair of rubber gloves for having solved the problem of how to clean small ducks when one has large hands. The good housekeeping award, an apron shaped like a pair of bloomers, went to Craig Sommerville. The award for animal training, a box of sawdust, was presented to W. J. Adams, who house-broke his dog in thirty-eight and a half days. W. Y. Lynn won the award for courage for having successfully refrained from giving in to his wife's plea for a new hat at $40.00. He was presented with veiling and two feathers to make one for her. R. E. Gottfred won the style award, an umbrella shaped hat, recognizing him as the best dressed golfer at a recent tournament.

All the awards were a complete surprise to the recipients.

Engineers in the News.

L. A. Bateman, council member of the Association attended the 37th annual meeting of the B.C. Association of Professional Engineers held in Vancouver.

W. A. Green, has been appointed vice-president and director of Hudson Bay Mining and Smelting Co. Limited at Flin Flon, Man.

Angus G. MacKenzie has been appointed assistant chief engineer of Sherritt Gordon Mines Ltd. at Lynn Lake.

C. L. Fisher was elected a director of the Canadian Good Roads Association at the thirty-seventh annual convention held in Quebec City.

M. Lasko has been appointed Winnipeg district engineer of the new district office opened by CSA Testing Laboratories in Winnipeg.

I. B. Henderson has been appointed general superintendent of the Greater Winnipeg Water District.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Col. D. H. McDougall, M.E.I.C., chairman of the board of MacKinnon Steel Corporation and president of the Frontenac Tile Company, died on December 4, 1956, at Montreal.

Donald Hugh McDougall was born in Sydney, N.S., on September 15, 1879, and was educated at public schools, the Government Mining School at Glace Bay, and Dalhousie College. In 1905 he undertook the management of the Dominion Iron and Steel Company's Wabana iron ore mines. Three years later he became general superintendent of ore

Col. D. H. McDougall, M.E.I.C.

mines and quarries for the same company. Named general superintendent in 1910 and general manager of the Dominion Coal Company in 1912, he was general manager of both these coal and steel companies in 1916. President of the Nova Scotia Steel and Coal Company in 1919, he received the appointment of vice-president of the British Empire Steel Company in 1921.

Three years later, in 1924, he severed direct connection with the twin industries of Nova Scotia and opened an office in Montreal as a consulting mining engineer. Over the past thirty years he originated, designed and developed many mining and engineering projects, not only in Canada but throughout the entire continent.

Colonel McDougall served as a director of many Canadian companies such as the McIntyre Porcupine Gold Mines, Steep Rock Iron Mines, Malartic Gold Fields, Inspiration Mining Company, Beaucage Mining Company, Canadian National Railways, Atlantic Sugar Refineries, Eastern Trust Company and Fleet Aircraft Limited.

In recognition of his contributions to the development of the Coal and Steel Industries of Nova Scotia, St. Francis Zavier University, in 1916, conferred on him an honorary degree of Doctor of Laws. On the Coronation of Queen Elizabeth II, Her Majesty was pleased to bestow on him the Coronation Medal.

Col. McDougall not only held the high office of president of the Mining Society of Nova Scotia, 1918-1919, and the Canadian Institute of Mining, 1919-1920, but gave unstintingly of his service and wise guidance as a member of the Councils of both, over a period of many years. First elected to the Council of the Canadian Institute of Mining in 1915 he served five separate appointments in this office for a total period of twenty-five years. Since 1941 until the time of his death he had served fifteen consecutive years as chairman of the executive committee of council. In 1955 named an honorary member of the Mining Society of Nova Scotia, he was, in 1956, at the time of his death, nominated for honorary membership in the Canadian Institute of Mining. He was a Life member of the organization.

He was also a member of the A.I.M.E., the American Iron and Steel Institute, and the Mining Institute of Scotland.

Col. McDougall joined the Institute in 1913 as a member and became a Life Member in 1948.

John Kirby Wyman, M.E.I.C., retired as-assistant to the port manager of Montreal Harbour for the National Harbour Board, died November 3, 1956, at Victoria, B.C., where he had been resident for the past six years.

Born at Hawkesbury, Ont., on July 31, 1883, Mr. Wyman received his engineering education at McGill University graduating in civil engineering in 1910. Beginning hs career with the Canadian eneral Development Company, St. Timothee, Que., on a canal for the Canadian Light and Power Company he was for five years associated with the John S. Metcalf Company on grain elevator construction, with the Bathurst Lumber Company and the Foundation Company of Canada.

At the outbreak of World War I he joined the Royal Engineers in England, winning a distinguished war record, and mention in despatches. After the war he continued to serve the Royal Engineers for an additional four years in India as an assistant director of military works at Lahore. He held the rank of major.

Returning to Canada in 1924, he worked for a time with the Department of Railways and Canals, in St. John, N.B., and Ottawa. Later in 1928, he was superintendent of the Port Colborne, Ont., grain elevator, and when an elevator was opened at Prescott, Ont., he became the first superintendent.

In 1938 he held the post of general superintendent of grain elevators, with the National Harbours Board, Montreal, and in 1949 became assistant to the port manager of the Montreal Harbours Board, the position he held until his retirement in 1950.

Mr. Wyman joined the Institute in 1907 as a Student member, was transferred to Associate Member in 1912 and became a member in 1940. He attained Life Membership in 1948.

Raphael Belanger, M.E.I.C., formerly vice-president of the contracting engineering firm of Deschamps and Belanger Limited, Valleyfield, Que., died on December 5, 1956, at Montreal.

Closely linked with Valleyfield, for many years, Mr. Belanger was born there on May 25, 1899. On gaining a B.A. degree at Valleyfield Seminary, he went on to engineering studies at the Ecole Polytechnique, Montreal, graduating with a B.Sc. degree in 1923.

City engineer at Valleyfield for a number of years, at the beginning of his career, he later went into private practice in the construction field in that district and finally in 1954 became a partner in the firm, Deschamps and Belanger Limited. He was appointed vice-president of the company in 1954.

Mr. Belanger joined the Institute as a Student Member in 1921, transferred to Associate Member in 1927, and became a Member in 1940.

Howard Fellows, M.E.I.C., formerly chief engineer with the Nova Scotia Power Commission, Halifax, and lately consulting engineer with the organization, died suddenly on November 17, 1956, at Halifax.

A native of Nova Scotia, Mr. Fellows was born at Stellarton, on August 3, 1894. He attended Mount Allison University from 1913 to 1915, and after four years machine shop and drafting room experience he enrolled at McGill University in 1919, graduating two years later with the degree B.Sc. in electrical engineering. Mr. Fellows joined the Nova Scotia Power Commission at Halifax in 1921 and continued to serve the company throughout his lifetime. Assistant chief engineer with the Commission in 1930, he was named chief engineer in 1946, and eventually became consulting engineer to the organization.

Mr. Fellows joined the Institute in 1930, as an Associate Member, and transferred to member in 1940.

Edward Stanley Carpenter, M.E.I.C., surveys engineer with the Dominion Department of Agriculture, P.F.R.A., at Regina, Sask., died on November 22, 1956 at Regina.

Mr. Carpenter was born at Gamebridge, Ont., on June 2, 1904. Brought up in Regina, he attended public and high schools in that city and then went on to study engineering at the University of Saskatchewan. He was awarded a B. Eng. degree in 1929, and during the first few years of his career gained experience as resident engineer with the Department of Highways, Province of Saskatchewan. After a number of years with P.F.R.A. at Regina, Mr. Carpenter joined the R.C.E., at the beginning of World War II and served overseas with the 14 Canadian A Fd. Coy. Returning to Canada in 1944 with the rank of captain, he was an instructor at the School of Military Engineering, Chilliwack, B.C., and in 1946 resumed his position as district engineer with P.F.R.A., located for a time at Saskatoon and later at Regina.

Joining the Institute as an Associate Member in 1931, he transferred to Member in 1940.

An active member of the Institute, he served the executive of the Saskatchewan Branch in 1947 and 1948.

He was also active in the Association of Professional Engineers of Saskatchewan.

Edwin Gerald Wyckoff, M.E.I.C., who was for many years a member of the staff of Otis Elevator Company, in Hamilton, Ont., died on November 13, 1956, at London, Eng., where he had been for a short time associated with Waygood-Otis Limited.

Born at Vittoria, Ont., on October 5, 1907, and educated at Simcoe High School and later at the University of Toronto, Mr. Wyckoff gained a B.A. Sc. degree in electrical enginering in 1930.

Employed with the Hydro Electric Power Commission of Ontario and the Otis Elevator Company Limited as a student, he remained with the latter firm after graduation and was employed at the Hamilton works, in charge of various manufacturing departments. Eventually administrative engineer in 1947 and head of the engineering department at Hamilton, he was later associated with the Warsaw Elevator Company as chief engineer. Works manager with Elevadoes Otis S.A. in Sao Paulo, Brazil in 1952, he was associated with the Otis Company at Bombay, India in 1955, before going to England.

Mr. Wyckoff served on the executive of the Hamilton Branch in 1946 and was elected chairman in 1948.

He joined the Institute in 1938, as an Associate Member, and was transferred to Member in 1940.

Gregoire Gareau, M.E.I.C., formerly chief engineer with Saguenay Electric Company Limited at Chicoutimi, Que., died on September 6, 1956 at Chicoutimi.

Born at St. Faustin, Terrebonne County, Que., on May 20, 1919, Mr. Gareau attended the Seminaire St. Therese de Blainville. Continuing his studies at Laval University, he graduated with a B.A.Sc. degree in electrical engineering in 1944.

He remained at Laval University in the capacity of professor from 1944 to 1948, and the following year joined Saguenay Electric Company at Chicoutimi.

Mr. Gareau was an active member of the Institute and was a member of the executive committee of the Saguenay Branch of the Institute. He was a member of the Corporation of Professional Engineers of Quebec.

Mr. Gareau joined the Institute as a Student Member in 1944, transferred to Junior in 1946 and became a Member in 1951.

Andrew J. Kowalchuk, JR.E.I.C., chief engineer for Brent Construction Company Limited, Edmonton, was killed in an auto accident on October 27, 1956. Mr. Kowalchuk was born in Poland on November 15, 1923. He followed his engineering studies at the University of Alberta, graduating with a B. Sc. degree in civil engineering in 1950.

First employed as a laboratory technician at the university, he accepted a position as field engineer with Brown and Root Limited, Edmonton in 1951. He joined the firm of Brent Construction Company Limited in 1955.

Mr. Kowalchuk joined the Institute in 1949 as a Student Member and in 1952 transferred to Junior member.

He was also a member of the Association of Professional Engineers of Alberta.

John Burton Gilliatt, M.E.I.C., retired chief engineer with Dominion Steel and Coal Corporation Limited at Wabana, Nfld., for many years, died at Annapolis Royal, N.S., on November 22, 1956.

Born at Granville Centre, N.S., on February 1, 1880, Mr. Gilliatt attended the University of New Brunswick and Dalhousie University, graduating with a B. Eng. degree from the latter in 1908.

Engaged in railway construction engineering with the National Transcontinental Railway throughout eastern Canada for the initial eight years of his career, except for a short term spent in the city engineer's office at Halifax after graduation, he joined the Dominion Steel and Coal Corporation Limited as resident engineer of the Wabana Mines in 1916 and held that position for the following six years. In 1922 he assumed the duties of chief engineer, which he continued to fulfill until his retirement in 1952.

Later, Mr. Gilliatt served on several engineering projects for the town of Annapolis Royal, on a part-time basis.

He joined the Institute as a Member in 1954.

CORRECTION

The Journal regrets the error which occurred in the obituary of J. E. Mikkelson in the November issue. It was stated that Mrs. Mikkelson was an engineer and had returned to practice in San Francisco. This is not correct. However Mrs. Mikkelson is employed in the engineering field.

Personals

News of the Personal Activities of Members of the Institute.

C. K. McLeod, M.E.I.C., of Montreal has been elected to the board of directors of the Permutit organization.

Earlier this year his election as president of Walter Kidde and Company of Canada Limited was announced. He has been associated with that organization as well as the Permutit Company since 1925.

Mr. McLeod is a former councillor of the Institute, 1940, and a past chairman and secretary-treasurer of the Montreal Branch from 1934 to 1936.

R. L. Dobbin, M.E.I.C., and **L. F. Grant,** two past-presidents of the Institute have been elected as aldermen in their respective cities.

Mr. Dobbin, of Peterborough, Ont., was formerly general manager of Peterborough Utilities.

Mr. Grant, Field Secretary of the Institute resides at Kingston, Ont.

Also elected to aldermanship at Kingston was **G. Vosper,** JR.E.I.C.

A. J. Lawrence, M.E.I.C., recently elected an alderman of Beaconsfield, Que., by acclamation, has also been elected to the advisory town planning commission of that district.

For many years employed with the Northern Electric Company Limited, Montreal, he is in charge of apparatus engineering standards with the organization.

J. M. Breen, M.E.I.C., president and general manager of Canada Cement Company Limited, Montreal, has been elected to the board of directors of Canadian General Electric Company Ltd.

He is also a director of Du Pont of Canada Securities Limited and its operating company, Du Pont Company of Canada Limited, the Montreal Trust Company, Canadian Refractories Limited, and the North American Life Assurance Company.

Mr. Breen has been associated with Canada Cement since 1922. He became president and general manager of the company in 1949.

R. S. Eadie, M.E.I.C., who has been appointed vice-president and manager of Dominion Bridge Company Limited, eastern division, is a graduate of McGill University.

Interrupted in his education during World War I, he joined the Canadian Engineers as a lieutenant and served in Canada and overseas. He resumed his studies on discharge and obtained his B.Sc. degree in civil engineering in 1920 and was awarded an M.Sc. degree shortly afterwards.

Lecturer in the Department of Applied Mechanics at McGill University on graduation, he held the position until 1924 when he joined Dominion Bridge Company in Montreal.

In 1935, Mr. Eadie was appointed design engineer and in 1937 was named assistant chief engineer. He became chief engineer of the Eastern division in 1944 and held this post until his recent appointment.

Thomas A. Somerville, M.E.I.C., has been appointed vice-president of E. G. M. Cape and Company, Montreal.

A B.Eng. graduate in civil engineering from McGill University, class of 1948, he has been with the firm since that date, serving at Halifax and Montreal. He now directs the Ontario operations of the company.

In 1953 he was named general superintendent of the organization at Montreal.

James Wheatley, M.E.I.C., former chief engineer of the shops and transportation department of the Quebec Hydro-Electric Commission has retired following eighteen years in this position.

Originally from New York state, Mr. Wheatley received his engineering qualifications at McGill University, obtaining a degree in mechanical engineering in 1912. Beginning his career with the Northern Electric Company upon graduation, he gained three years' experience in the design and manufacturing field and then accepted a position with the British Munition Company Limited of Verdun where he was engineer in charge of the design of tools and manufacturing, during World War 1. He also served for a short period of time with the Canadian Engineers in Canada.

Rejoining the staff of Northern Electric Company at the end of hostilities, he was employed in the power apparatus sales division for some time.

Assistant superintendent of the bolt and nut department of the Steel Company of Canada at Montreal in 1923 he remained with the firm for three years.

In 1926 he became associated with Domestic Gas Appliances Limited, a subsidiary of the Montreal Light, Heat and Power Consolidated, at Montreal, which firm was later in 1944 to become known

C. K. McLeod, M.E.I.C.

R. S. Eadie, M.E.I.C.

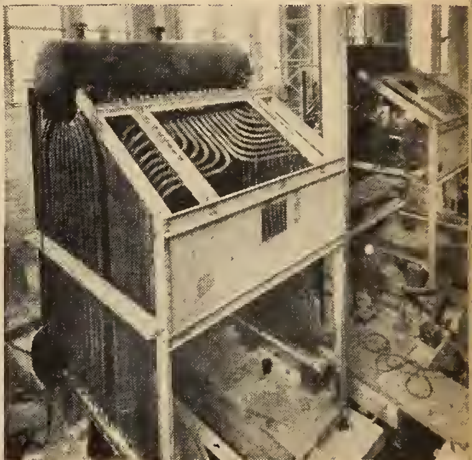
J. M. Breen, M.E.I.C.

Microwave parabolic reflector for transmitting ultra-high frequency waves. Mechanical design, fabrication and erection by Dominion Bridge for RCA Victor Company Limited.

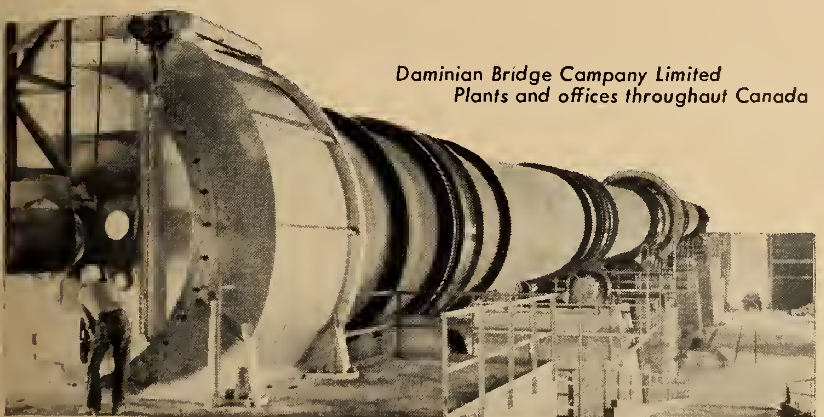
On the job...

Completely enclosed 250-ton gantry crane, with 60-ton crane at right. Both are installed at the Peribonka power house of the Aluminum Company of Canada. We are now building a 300-ton crane of same type for St. Lawrence power project — largest ever built in Canada.

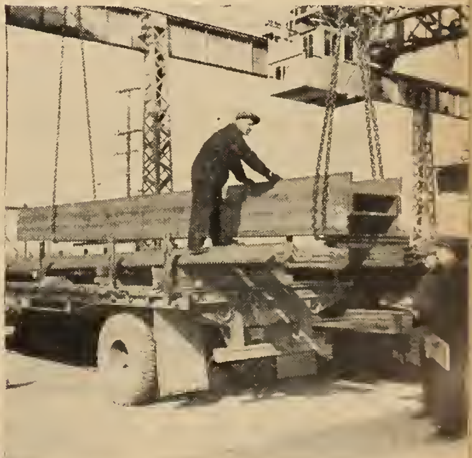
This rotary kiln is 450 ft. long, 12 ft. diam. and weighs approx. 700 tons. Largest in Canada — it is capable of producing 1,500,000 barrels of cement annually. Fabricated and erected by Dominion Bridge for Canada Cement Company, Fort Whyte, Man.



Three 25,000 pph Dominion Bridge water tube boilers installed in St. Justine Hospital, Montreal.



Dominion Bridge Company Limited
Plants and offices throughout Canada



Modern handling and shipping methods assure prompt delivery of Dominion Bridge Warehouse steel.

with Dominion Bridge

• PERSONALS

as the Quebec Hydro-Electric Commission.

In 1938 he was transferred to the industrial department of Montreal Light, Heat and Power Consolidated as manager of the gas division of the firm. In the same year he was transferred to the shops department as mechanical superintendent and general superintendent of shops and the garage department, prior to assuming the duties of chief engineer of the shops and transportation department.

Mr. Wheatley was elected a Life Member of the Institute in 1954.

Garth Griffiths, M.E.I.C., of Victoria, B.C., is the choice of the Vancouver Island Branch of the Institute as chairman for the coming season.

Last year appointed assistant to the general manager and also director of administration with the British Columbia Power Commission, Victoria, Mr. Griffiths has been associated with that organization since its inception in 1946.

At that time he was discharged with the rank of major from the R.C.E.M.E. technical staff, following three years' military service. This included liaison work with the design and production authorities and with British Army Staff in Ottawa and Washington, and a short tour of duty in the United Kingdom and northwest Europe.

Mr. Griffiths is a graduate of the University of British Columbia in electrical engineering, class of 1941.

C. G. J. Luck, M.E.I.C., who retired from his position as assistant engineer with the National Harbours Board at Churchill, Man., in 1955, now lives at Saanichton, Vancouver Island, B.C. He is an assistant engineer with the British Columbia Forest Services.

Engaged in engineering since 1905, the date of his graduation from the Central Technical College, London, Eng., his career has entailed a variety of experience. In Canada as early as 1920, he had behind him several years' military service with the British Expeditionary Force. At the end of the war in 1919, also with the B.E.F., he was instrumental in the reconstruction of the Murman Railway, in Northern Russia. Mr. Luck was awarded the M.C. with Bar on his discharge from the Army.

J. H. Wheatley, M.E.I.C.

G. Griffiths, M.E.I.C.

Employed with the firm of Ewing, Lovelace and Tremblay, Montreal, in 1920, he also held appointments with Fraser-Brace Engineering Company Limited during the 1920's, and the Gatineau Power Company.

He was associated with the Ontario Hydro-Electric Commission, the Beauharnois Construction Company at Beauharnois, Que., and the C.P.R., at St. John, N.B., in the following decade.

His association with northern Canada began in the mid-thirties, when, turning to engineering projects with the Department of Northern Development, he was employed at Kenora, Hudson and Port Arthur, Ont. Later in 1940 he went to Churchill, Man., to accept a post with the National Harbour Board as an assistant engineer.

Mr. Luck was elected a Life Member of the Institute in 1956.

Edward R. Zacharias, M.E.I.C., has been named general manager of engineering and manufacturing services for the Thermoid Company, Trenton, N. J.

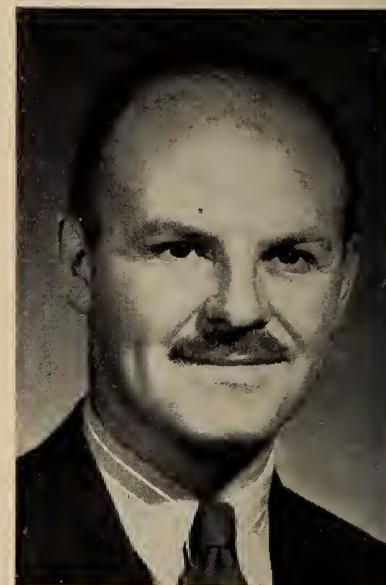
With Thermoid since 1950, he was for eleven years prior to that time factory manager of the Stokes division, General Tire Rubber Company, Welland, Ont.

A graduate of the University of Saskatchewan, class of 1935, he has a B.Eng. degree in civil enginering.

Harry S. Spark, M.E.I.C., port engineer with the National Harbours Board at Montreal has retired after more than thirty-three years' service.

A native of Scotland, Mr. Spark came to Canada in 1912 following two and a half years' apprenticeship with a Dundee engineering and shipbuilding firm, on completion of his engineering studies.

Initially employed in Canada with Canadian Explosives Limited, in the design field, until 1914, he then joined the Montreal Filtration and Aqueduct Works and took part in the preparation of hydraulic studies and designs for re-



P. B. French, M.E.I.C.

taining walls and a power house at the low level pumping station at Montreal.

With Canadian Vickers Limited from 1917 to 1921, he was employed as an assistant chief draughtsman, before joining the Harbour Commissioners of Montreal as an assistant engineer.

He became assistant chief engineer in 1944 and in 1947 assumed the top position of port engineer.

Mr. Spark has been largely responsible for the extensive building program now under way in the harbour in preparation for the opening of the Seaway.

John M. Hansen, M.E.I.C., town engineer at Fort Frances, Ont., in 1955, has accepted an appointment as resident engineer with the Department of Public Works, Banff, Alta.

A Danish engineer from the Royal Technical College, Copenhagen, Mr. Hansen has had varied experience in this country, working on the staff of W. M. Barnes, general contractor in Edmonton, as designer and draughtsman, and later in 1949 with Sparling and Davis, Edmonton, in the general contracting field. He has also been associated with the City of Edmonton engineering department, and in 1951 joined Defence Construction Limited at Edmonton. In 1954 he became town engineer for Dauphin, Man.

Vassyl Nakonechny, M.E.I.C., of Canadian Vickers Limited, Montreal, has been

promoted from senior draughtsman, Marine drawing office, to estimator, in the industrial drawing office.

With Canadian Vickers for a number of years Mr. Nakonechny came to this country originally from Belgium where he studied engineering at the University of Louvain, Belgium.

Philip B. French, M.E.I.C., of Lyman Tube and Bearings Limited, Montreal, has been recently appointed vice-president in charge of sales with the firm.

Mr. French, who has been with the firm for a number of years, as bearings sales manager and branch manager, has also had experience with the Ahlberg Bearing Canada Limited, Montreal and with Canadian SKF Co. Ltd., since graduating from McGill University in 1934.

H. Chaput, M.E.I.C., of the Ottawa Transportation Commission has been named manager of equipment and power following several years' service with the organization.

Mr. Chaput graduated from Queen's University in 1941 with a B.Sc. in electrical engineering, and completed the test course with the Canadian General

H. Chaput, M.E.I.C.

Electric Company the following year. With the R.C.A.F. as a signal officer and pilot, from that time until the end of the war, his next engineering assignment was with the English Electric Company, St. Catharines, Ont. as a design engineer. In 1949 he was appointed electrical engineer with the Ottawa Transportation Commission. He became assistant to the general manager in 1952.

C. C. Purves, JR.E.I.C., a 1950 graduate of the University of New Brunswick, in civil engineering is working with the British Columbia Power Commission at Victoria, as an assistant generation planning engineer.

Mr. Purves had previously been associated with the Montreal Engineering Company Limited, Montreal.

J. A. Dake, JR.E.I.C., a 1954 graduate of the University of Edinburgh, in electrical engineering, and formerly a design engineer with the Bell Telephone Company of Canada, has found employment with International Business Machines Company. Located at Don Mills, Ont., he is concerned with the plant engineering department.

John R. Challis, JR.E.I.C., has resigned from the staff of James F. MacLaren and Associates, consulting engineers, Toronto and has taken a position with the Saint Lawrence Seaway Authority, as specifications writer.

He is a University of Toronto graduate in civil engineering, class of 1951.

Dr. John Duby, JR.E.I.C., holds a sessional appointment with the University of Alberta electrical and civil engineering departments.

A graduate of that University, he was awarded a B.Sc. degree in chemical engineering in 1952, later attending Brasenose College, Oxford, Eng.

J. A. Cowlin, JR.E.I.C., of Victoria, B.C., has been elected secretary-treasurer of the Vancouver Island Branch of the Institute for the 1956-57 season.

An assistant engineer on the design of municipal services, he began work in this field in 1954 when he joined the engineering department of the municipality of Saanich as an engineering assistant on sewer construction.

Mr. Cowlin has also been employed with the Consolidated Mining and Smelting Company at Trail, B.C., since graduating from the University of British Columbia in 1952. He was awarded a B.A.Sc. degree in civil engineering.

R. G. Nicholls, JR.E.I.C., is with the Great Plains Development Company, Calgary. He was formerly associated with the Shell Oil Company, gas division, in that city. He is a 1954 graduate in mechanical engineering, University of Manitoba.

D. P. Murray, JR.E.I.C., has severed his connections with the Otis Elevator Company Limited and has accepted a position as sales engineer with the American Air Filter Company of Canada, located at Hamilton. He is a 1949 graduate of the University of Manitoba.

B. F. Willson, M.E.I.C., of Edmonton, has been appointed vice-president of operations with the Canadian Western

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Correction: The *Journal* regrets that in the January issue of the *Journal* it was incorrectly stated that H. D. Scothorn, JR.E.I.C., is employed with the Department of National Defence, Directorate of Works, Ottawa.

Mr. Scothorn is a mechanical engineer on loan to the Dominion Government from the firm of A. D. Margison and Associates Ltd., Toronto.

• PERSONALS

Natural Gas Company Limited, Edmonton, and with Northwestern Utilities Limited.

On graduation from the University of Alberta in civil engineering in 1943, Mr. Willson joined the Royal Canadian Engineers. On discharge in 1945, he joined the staff of Northwestern Utilities Limited in Edmonton and became assistant general manager of that company in 1953.

A year later he was transferred to Calgary to assume the post of director of administrative services, an inter-company department of Canadian Western Natural Gas Company Limited and Northwestern Utilities Limited. Election to the board of directors of both companies followed in April 1956.

H. M. Hunter, M.E.I.C., of the Canadian Western Natural Gas Company Limited, Edmonton, has been named general manager with the organization.

A graduate of the University of Alberta, class of 1927, he joined the geological department of the gas company at that time.

Mr. Hunter served overseas with the Royal Canadian Enginers from 1939 to 1945, and on his return to Canada with the rank of major, was appointed general superintendent of the company in 1946.

In 1955 he was appointed manager of the plant division.

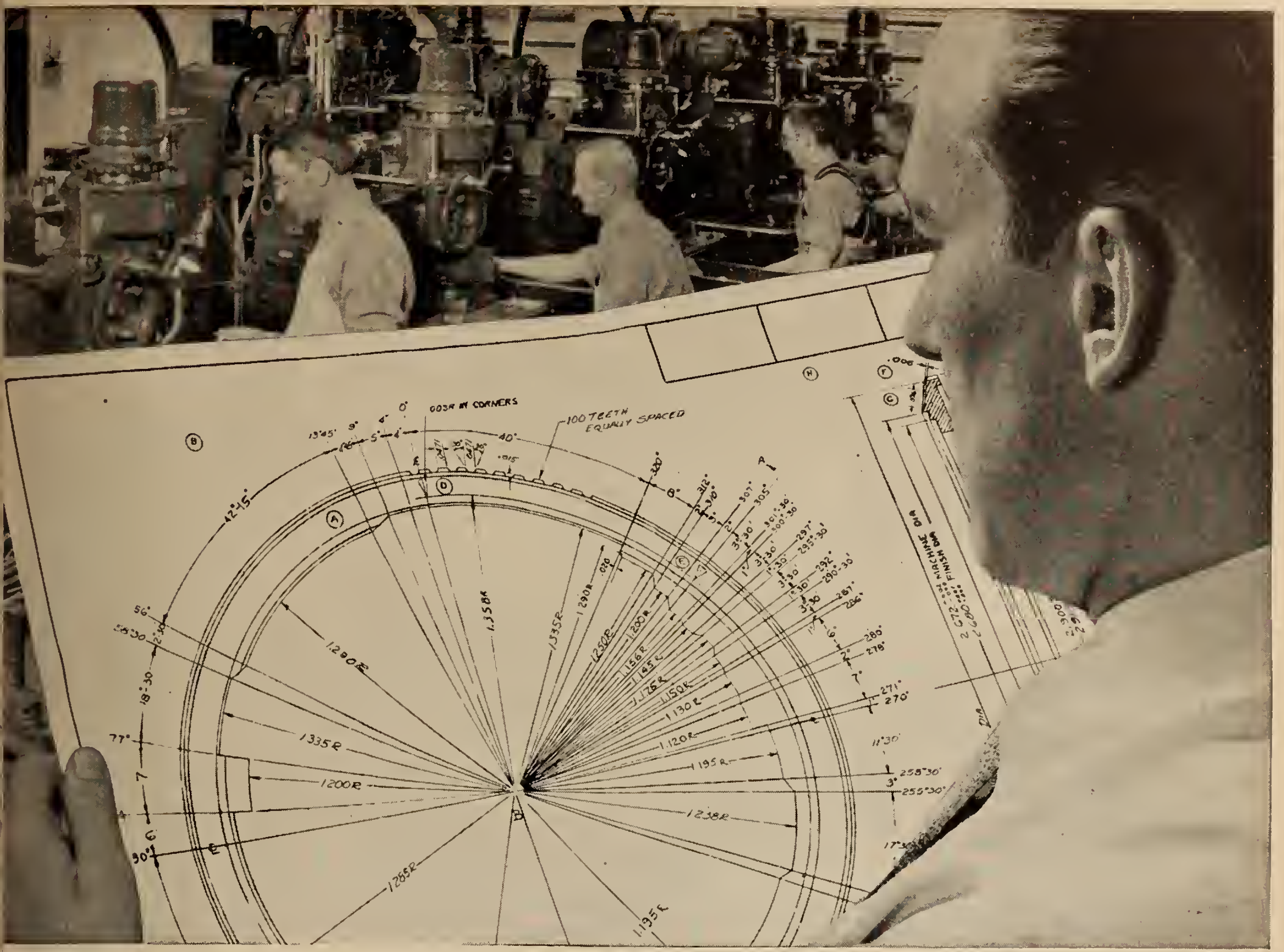
Robert B. McRuer, M.E.I.C., is methods and scheduling supervisor with Du Pont of Canada Limited, Maitland, Ont., on a new plant being constructed for the manufacture of acrylic fibre.

Mr. McRuer is a 1948 graduate of Queen's University in chemical engineering.

H. D. Brydone-Jack, M.E.I.C., of Montreal, engineer of construction with the Canadian Pacific Railway, whose employment with the organization dates to 1911, has retired and is living in Montreal.

Mr. Brydone-Jack joined the C.P.R. staff as an assistant engineer in 1911 on receiving a B.Sc. degree from McGill University. With the outbreak of World War I he went to England in 1915 and joined the Royal Horse and Royal Field Artillery. In the closing year of the war he was captain of the 29 Battery, R.F.A., with the Third Division Artillery. For his part in the battle of Loos he received mention in despatches and was awarded the Military Cross in 1918.

At war's end returning to his position as an assistant engineer with the C.P.R., he later in 1920 obtained leave of absence from the company to undertake the duties of superintendent of Sydney Junkins Company Limited, engineers and constructors. Active with the C.P.R. in



• PERSONALS

1927 he was promoted to the position of assistant manager of personnel in 1932, to acting manager of personnel in 1942 and in 1946 was named manager of that department. The following year he took over the duties of engineer of construction, the position he held at the time of his retirement.

J. A. Beveridge, M.E.I.C., city commissioner at Red Deer, Alta., since 1952, has transferred his services from that locality to the southern Saskatchewan city of Moose Jaw.

Mr. Beveridge is originally from British Columbia, where he obtained a B.A. Sc. degree at the University of British Columbia in 1947. Furthering his studies at John Hopkins University, and specializing in sanitary engineering and soil mechanics, he attained the degree of master of science in 1950. He enrolled in the management training course at the Banff School of Fine Arts in 1956.

A junior engineer with Canadian Industries Limited, he worked on plant construction during 1947-48. Later, on leaving John Hopkins University in 1950 he was for two years sanitary engineer for the province of Alberta.

During that time he was a member of the Alberta provincial board of health, a director of the Western Canada Water and Sewage Conference, and a lecturer at the University of Alberta.

Within the last few years he has served as a member of the Legislative Committee of the Union of Alberta Municipalities; as a member of an Associate Committee working on the National Building Code; and as district representative of the Community Planning Association of Canada.

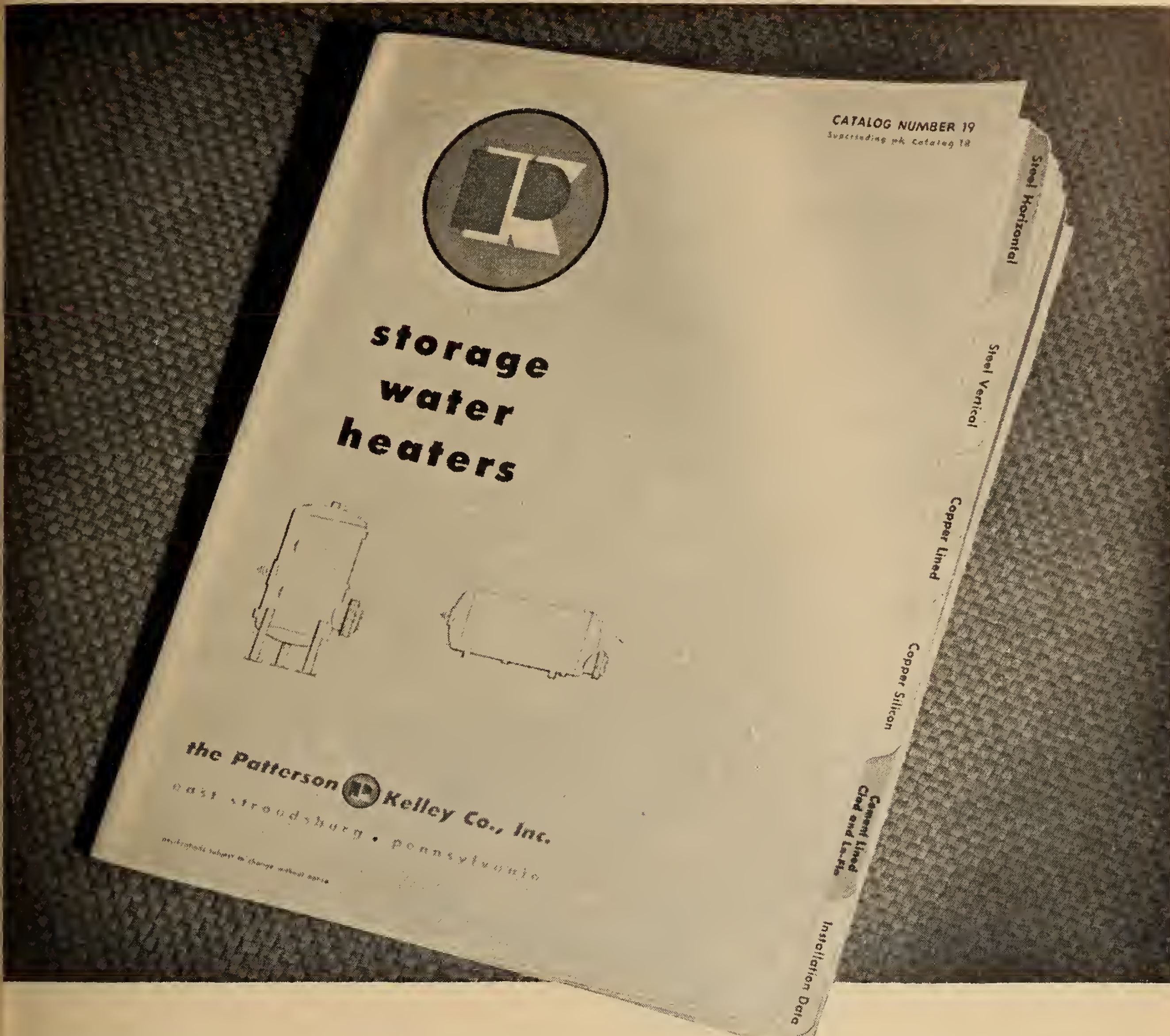
M. Eagle, M.E.I.C., formerly of Sorel Que., with Quebec Iron and Titanium Corporation, has accepted a position in Western Canada with Pioneer Electric Alberta Ltd., at Red Deer, Alta.

A graduate of the University of British Columbia, class of 1948, Mr. Eagle has since that time held appointments with the Manitoba Paper Company, Pine Falls, Man., as an assistant to the electrical superintendent, and with the Canadian Brazilian Traction, Light, and Power Company, at Rio de Janeiro, before joining the Quebec firm in 1953.

J. S. MacDonald, M.E.I.C., who was last year associated with the Tide Water Oil Company, Regina in the capacity of geologist, has gone to South America. He is employed with the Venezuelan Atlantic Refining Company.

John G. Kerfoot, M.E.I.C., 1956-57 chairman of the Brockville Branch of the Institute is a Queen's University graduate, class of 1936, and is employed as a plant engineer with Automatic Electric (Canada) Limited, at Brockville, Ont.

Mr. Kerfoot began his engineering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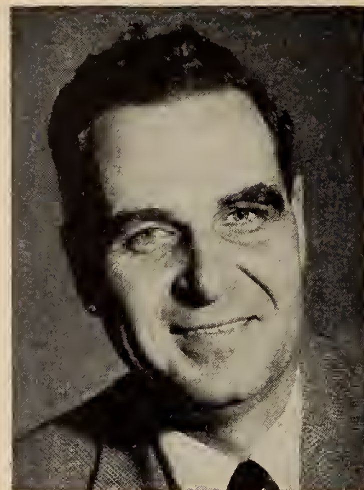
career with Phillips Electrical Works Limited in Brockville in the telephone manufacturing department shortly after his graduation. From this position he moved on to work for Defence Industries Limited during the early war years, as a supervisor on production and on tool design and process. Later, he served the Royal Canadian Navy at sea.

Associated as a partner in a small precision manufacturing business in Kitchener, Ont., at the end of hostilities, Mr. Kerfoot gave this up in 1948 to rejoin the staff of Phillips Electrical Works Limited, as an assistant plant engineer. In 1951 he transferred his services to the Kaiser Aluminum Corporation at Newark, N.J., as an assistant plant engineer.

He has been associated with the Automatic Electric (Canada) Limited since 1953.

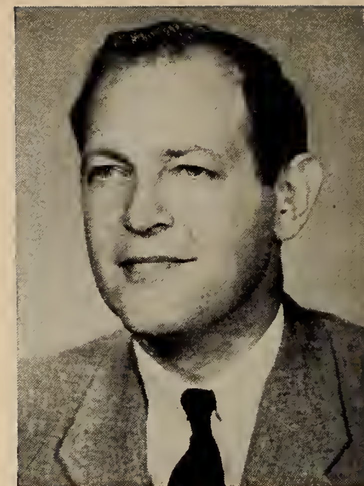


L. W. Locke, M.E.I.C.

Lorne W. Locke, M.E.I.C., now resides in Seattle and is employed with The Boeing Airplane Company as an electrical design engineer in the transport division at Renton, Wash.

Previously maintenance engineer with the B.C. Power Commission, he has also practised engineering in Winnipeg where he was on the engineering staff of the City of Winnipeg Hydro Electric System and served in various capacities in the production and engineering design division, holding the position of operating engineer from 1951 to 1955.

A graduate of the University of Manitoba, he received his degree in electrical engineering in 1948.



D. C. R. Miller, M.E.I.C.

D. C. R. Miller, M.E.I.C., has been named vice-president of Dow Corning Silicones Limited at Toronto.

Holding a professional degree in mechanical engineering from the University of Toronto, Mr. Miller was formerly associated with Duplate Canada Limited and with Fiberglas Canada Limited. He managed sales of Dow Corning Silicones at Toronto, for Fiberglas from 1948 until the formation of the present company in 1953 at which time he was appointed general manager.

He will continue as general manager of Dow Corning Silicones Limited in addition to assuming his new duties as vice-president.

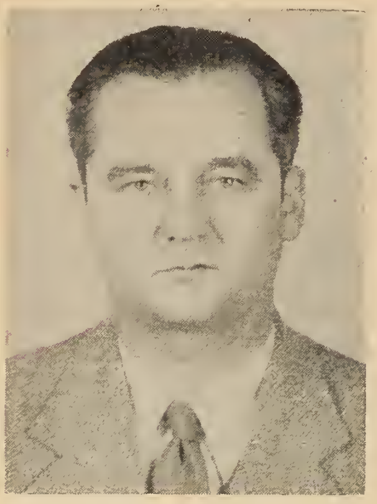
Stanley A. Barnas, M.E.I.C., supervisory civil engineer in the office of the area engineer, Corps of Engineers, U.S. Army, Goose Bay, Labrador, is engaged on the construction of the Goose Air

• PERSONALS

Base, the Pinetree Line and Mid-Canada Line.

Resident in Canada since 1954, he is a native of Poland, and had his engineering training in England after World War II. He graduated from the South West Technical College and School of Art, London, class of 1951, on completion of a four-year course in civil and structural engineering.

Mr. Barnas served with the Polish Army during the war, in the Middle East and in Italy.



S. A. Barnas, M.E.I.C.

Following his graduation Mr. Barnas was employed with the Lummus Company Limited, designing engineers and constructors for petroleum and chemical industries, of London, England, as a structural engineer, and also with Orlit Limited, Colnbrook, Eng., as senior engineer.

He is an engineer-member of the Society of American Military Engineers, and an Associate Member of the Institution of Structural Engineers.

E. Heaton, M.E.I.C., a graduate of the National University of Ireland, class of 1947, has accepted a position with the Montreal Engineering Company, consulting and operating engineers, civil engineering section, at Montreal.

Mr. Heaton was formerly associated with the St. Lawrence Seaway Authority, hydraulics section, at Montreal and carried on the work of investigation engineer.

N. F. Stewart, JR.E.I.C., is the choice of the Prince Edward Island Branch of the Institute for chairman, for the term 1956-57. He was elected to the executive in 1955.

After a war record in which Mr. Stewart served with the Royal Canadian Artillery, and with the R.C.A.F., he enrolled at Dalhousie University to begin engineering studies. Awarded a diploma in engineering from that college in 1949, he went on to further studies at the Nova Scotia Technical College and in 1951 obtained the degree of Bachelor of Engineering.

Field engineer with H.M.C. Dockyard, Halifax, in the civil engineering and maintenance department, for the next two years, he accepted his present position with the County Construction Company Limited in 1953 and serves as construction engineer and estimator with the firm.

S. Cherry, JR.E.I.C., formerly on the staff of the University of Manitoba civil engineering department, has gone to Vancouver where he is at work at the University of British Columbia, also in the civil engineering department.

Mr. Cherry graduated in 1949 from the University of Manitoba, and carried out graduate research work at the University of Illinois. Later he was associated with the University of Bristol engineering laboratories.

Dr. C. R. Cupp, JR.E.I.C., has left the International Nickel Company of Canada, Copper Cliff, Ont., research department and has accepted a position with the Canadian Westinghouse Company Limited, Grimsby, Ont.

Senior metallurgist, in the metallurgical-mechanical section, research and development laboratories, Dr. Cupp is a University of Toronto graduate. He was awarded a B.A.Sc. degree in metallurgy in 1950, followed by a Ph.D. in 1953.

V. G. MacWilliam, JR.E.I.C.

E. J. Grant, JR.E.I.C.

V. G. MacWilliam, JR.E.I.C., of Atholville, N.B., secretary-treasurer of the Northern New Brunswick Branch for the present term of office, is a native of Petitcodiac, N.B., and a 1949 graduate of the Nova Scotia Technical College.

Mr. MacWilliam, who also has an engineering diploma, gained at Dalhousie University prior to enrolling at N.S.T.C., worked for three years as a machinist in St. John, N.B., before commencing his studies.

With the Nova Scotia Power Commission as a construction engineer on mill renovation at Trenton, N.S., from 1949 to 1951, he has since then spent a number of years in the same type of work with Irving Pulp and Paper Limited, as a construction engineer at Lancaster, N.B.

At present Mr. MacWilliam is associated with the Restigouche Company Limited, Atholville, which he joined in 1955.

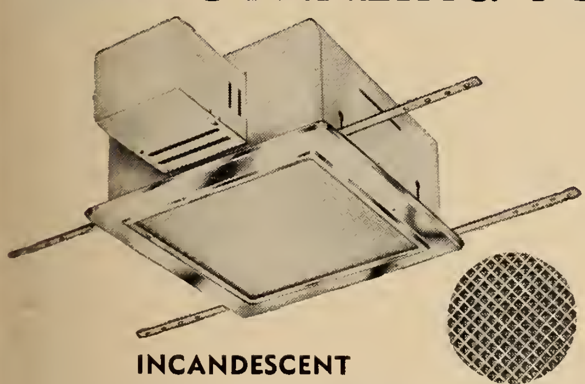
Active in the Canadian Pulp and Paper Association, Atlantic Branch, technical section, as mill representative for Irving Pulp and Paper Limited, in 1954, he also acted as mill representative for the Restigouche Company, Limited during 1956.

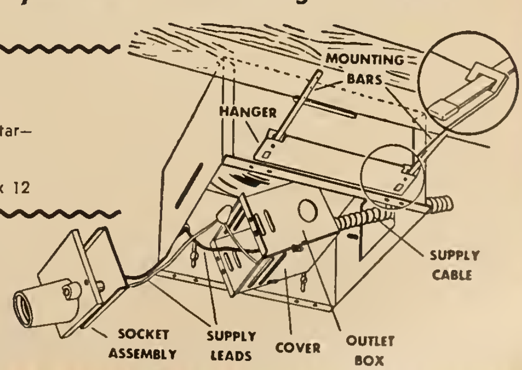
E. J. Grant, JR.E.I.C., a 1954 graduate of the University of New Brunswick, for the past two years studying in Great Britain under the provisions of an Athlone Fellowship, returned to Canada a number of months ago and is employed with the Foundation of Canada Engineering Corporation, Montreal, as a structural engineer.

While in Great Britain, Mr. Grant spent one year at Imperial College, London University, where he specialized in the study of pre-stressed concrete, under the supervision of Dr. A. L. L. Baker. He was honored in the award of the D.I.C. (Diploma of Imperial College).

During his second year he was asociated with a consulting engineering firm, also located in London.

While abroad Mr. Grant had the opportunity to visit industrial plants, touring several European countries.





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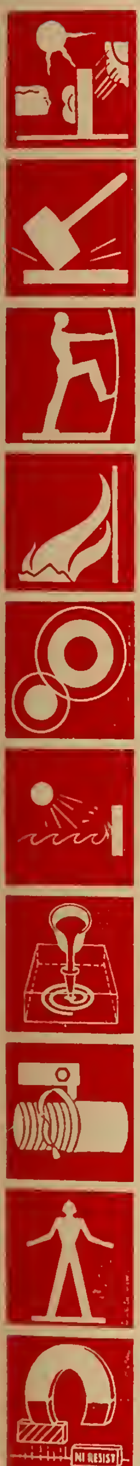

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Toughness: The impact resistance of ductile Ni-Resist irons is comparable to that of steel at ordinary temperatures. Also like other nickel-containing austenitic alloys, it suffers no appreciable embrittlement at sub-zero temperatures.

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Heat Resistance: Up to 1300°F., with some types as high as 1500°F. Ductile Ni-Resist Irons greatly reduce the oxidation rate but enable the oxidation products to adhere to base metals, making them especially useful in engine manifolds and superchargers.

Wear Resistance: Engine and pump liners, pistons, bearings, glands and other metal-to-metal rubbing parts last longer and perform better, especially under corrosion conditions, when made of ductile Ni-Resist irons.

Erosion Resistance: Corrosive slurries, wet steam, etc., are extremely erosive on most metals. The ductile Ni-Resist series of alloys shows economical service under many erosion conditions.

Fluidity (Castability): The good flowing quality of ductile Ni-Resist irons in the molten state permits making intricate designs which are difficult to provide in some other cast metals.

Machinability: The machinability rates of ductile Ni-Resist irons are of the same order as those of conventional pressure type gray iron. Both of these factors aid materially in producing finished parts economically.

Controlled Expansion: Expansivities from 4.5 to 10.4 millionths per °F are available with various types of ductile Ni-Resist Irons. Metals of different expansivities can be matched with selected Ni-Resist types.

Non-Magnetic: Some types of ductile Ni-Resist irons are non-magnetic and therefore are useful in many applications in the electrical and allied fields where this quality, plus machinability, heat resistance, etc., are required.

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Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

BELLEVILLE

E. T. HILBIG, JR.E.I.C.,
Secretary-Treasurer

Controlled Volume Pumping

J. W. Halls of Consolidated Engines and Machinery Company, Montreal, delivered a comprehensive talk supplemented with slides, on controlled volume pumping, at the general meeting of the Belleville Branch, held December 10, 1956.

The pumps used are almost invariably the piston type having adjustable stroke length. The volume pumped is generally controlled using thymotrols for varying the speed of the D.C. motor driving the pump. The thymotrol unit itself is activated by a flow recorder of various types. Of particular interest was the method in which air could be employed as the medium for controlling the output of the pumps.

While controlled volume pumping could no doubt be accomplished by other means such as a variable speed centrifugal pump, the extreme accuracy (tolerance of less than 1 per cent) of the piston type of pumps together with a duplicate valve system makes them highly preferable for formulating products in the chemical and allied industries.

Mr. Halls brought with him two types of controled volume pumps, one of which he dismantled in order to show the component parts. Considerable interest was shown by the group in the two models displayed.

CAPE BRETON

W. L. DODSON, M.E.I.C.,
Secretary-Treasurer

E. J. PRINCE, M.E.I.C.,
Branch News Editor

Annual General Meeting 1956

The annual general meeting of the Cape Breton Branch was held on Friday, December 14, 1956, at the officers' mess, Victoria Barracks, Sydney, N.S. E. Jack Prince was in the chair at the beginning of the meeting, his place being taken later by W. A. MacDonald, newly elected chairman for 1957.

Mr. Prince thanked the 1956 committee for their whole-hearted support during the year. He also thanked Branch members for their enthusiasm in attending meetings. A successful year in every way for the Branch, meetings had been well attended in 1956 and a variety of technical and engineering subjects dealt with by a number of capable speakers.

The secretary then gave his report and this was followed by the reports of the sub-committee chairmen. The thanks of the branch were extended by the entertainments sub-committee chairman to all those companies who had materially helped in making the dinner meetings a success.

The secretary then gave his report Park and Cliff Roach, reported that the following Branch officers and executive had been duly elected for 1957: W. A. MacDonald, Branch chairman; V. Palmer, vice-chairman; W. A. Dodson, secretary; C. A. Campbell, treasurer.

The executive committee consists of D. Wilson, R. Bradley, J. Richard, H. Aspinall, G. W. Ross, H. Maitland, and F. MacDonald.

M. R. Campbell has been chosen as the Member of Council and J. R. Wallace elected to the nominating committee.

CORNWALL

L. SNELGROVE, M.E.I.C.,
Secretary-Treasurer

V. A. HARRISON, M.E.I.C.,
Publicity Chairman

Cornwall Student Bursary

Friday, December 7, 1956 was the date of an interesting and important event in the history of the Cornwall Branch, and indeed in the affairs of the Institute. Before a dinner meeting of branch members and their ladies, E.I.C. president, V. A. McKillop presented for the first time the Colonel W. H. Magwood Bursary.

These cash grants are for the purpose of assisting engineering students to obtain a course at a university of their choice. Candidates are restricted to residents of the three counties surrounding Cornwall, and high academic standing is not the only criterion for selection. The eligible students must also be financially deserving of help, and with a

The presentation of the Colonel Magwood bursary. Shown together, left to right, are: Drummond Giles, chairman of the bursary committee, Kent Plumley, H. R. Sills, of Peterborough, V. A. McKillop, president of the Institute, Jack Morris, chairman of the Cornwall Branch, John Hawkes, councillor, and Donald Plumley.

recognizable zeal for a higher engineering education. The bursary has been named to honour Colonel W. H. Magwood, a retired engineer living in the same city, and a well known and greatly respected citizen of the Cornwall area. He became a leading figure in the professional life of that community, and served for many years as the city engineer.

President's tour of the St. Lawrence Seaway Power Project. Left to right are: V. A. Harrison, D. C. McEwan, W. Rothwell, Jack Morris, chairman, Cornwall Branch, G. Mitchell, director of the Project, all of Cornwall, and E. C. Luke, Associate Editor of the Journal, President V. A. McKillop, and William Hogg, field project engineer.

On this occasion the recipients were two brothers, Kent and Donald Plumley, and each one was given a certificate and the sum of $600.00 to pursue his studies at Queen's University, Kingston. Those who attended the presentation could not help being impressed with the high calibre of the young men selected.

The funds to create this bursary were collected locally by the Cornwall Branch, through a committee under the chairmanship of Drummond Giles, M.E.I.C., a past vice-president and councillor of the Institute, and prominent member of the Branch.

The *Journal* and the officers of the Institute wish to pay a special tribute to those of the Cornwall Branch whose imagination and initiative have brought this fine bursary into being. We think it makes a fine target for other branches to aim at in their similar endeavours.

President's Visit

On the occasion of the president's visit to the Cornwall Branch, December 7, President McKillop, accompanied by E. C. Luke, Assistant General Secretary, joined the executive of the Cornwall Branch, headed by chairman Jack Morris, for a luncheon at the Cornwallis Hotel.

NOVA SCOTIA PENSTOCK

Engineered and installed by the Nova Scotia Power and Light Company, Ltd., this 66″ line was covered from 4′ to 17′ deep. Pipe was made by Halifax Ship Yard; pipe and couplings were bituminous coated. Wall thicknesses range from $3/8''$, $1/2''$, $9/16''$ to $5/8''$ for line pressures of up to 195 psi.

BIG JOB, SMALL WRENCH

From a reservoir served by the Nictaux River, 100 miles southwest of Halifax, water now flows via canal and wood stave pipe to this 3312′ Dresser-Coupled steel penstock.

The lighter weight, high-strength steel pipe was delivered to the job with Dresser Coupling middle rings and followers already in place. It was a simple matter to swing the long pipe lengths into the ditch. Then workmen put in the bolts and tightened the end nuts. *A wrench was the only joining tool required.*

That's how it is on all Dresser-Coupled jobs. No expensive skills or equipment are needed. Work can proceed in any weather at an average of only two man-minutes per bolt. And there's no need for exact pipe fitting or alignment. The resilient rubber gasket in every Dresser Coupling absorbs line stresses, strains and movement . . . permits expansion and contraction . . . keeps joints bottle-tight and trouble-free for life!

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A brief but lively discussion on the question of Confederation took place during the affair.

Later the group drove west of Cornwall to Ontario Hydro's administration building, headquarters for the St. Lawrence Power Project. The president met Gordon Mitchell, M.E.I.C., project director, and renewed acquaintances with W. M. Hogg, M.E.I.C., field project engineer

Tour of Project — Mr. Mitchell and Mr. Hogg conducted the president and his party on a tour of the Project which included the main dam and power house at Barnhardt Island, the Long Sault control dam on the American side of the St. Lawrence River and the Eisenhower lock on the U.S. section of the St. Lawrence Seaway. On returning to the Canadian side the president was shown the house moving operation, where houses were being removed from the village of Wales which will be completely flooded by the head pond of the power house. The new town of Long Sault was the last point of interest. This town, which will replace the villages of Mille Roches and Moulinette, is now well established with over 100 houses having been already moved into it.

In the evening, the dinner meeting at the Northway Hotel was very well attended by the branch membership.

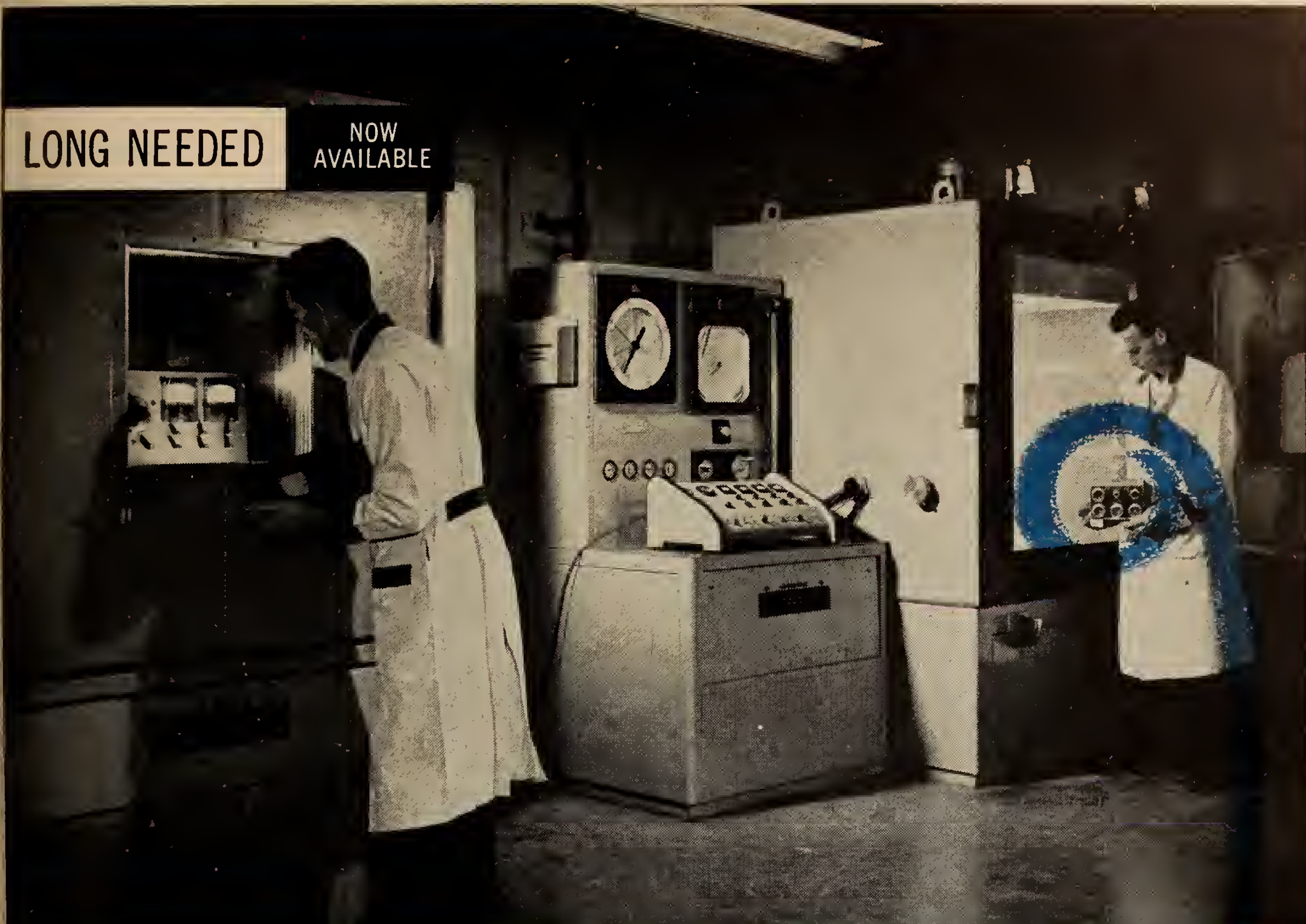
After a most enjoyable meal and the presentation of the Colonel Magwood bursary, the president delivered an interesting address on the Engineering Institute of Canada under three main headings; Its Ambitions, Its Achievements and Avenues Ahead.

Mr. McKillop also expressed a keen interest in seeing the confederation of engineers become a reality. 'The problem presently facing the Associations in each of the provinces is not unlike that faced by the Fathers of Confederation," he said. "We should, like them, emphasize the common ground and minimize our differences and proceed with confederation with faith in its ultimate success." It was, he felt, becoming increasingly essential to have unified representation of all professional engineers in Canada on both national and international questions.

The president was thanked by John Hawkes, Branch councillor, who expressed the very real pleasure the presidential visit had afforded.

Mr. Luke expressed the thanks of the Montreal headquarters and himself for the hospitality which had been so evident. He also, on behalf of the head office of the Institute, expressed their desire to be of service to all members whenever possible.

Branch chairman, Jack Morris, subsequently adjourned the meeting.



Preparing to test a Company produced rocket-firing intervalometer at −65° F. at 60,000 feet altitude

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HAMILTON

A. F. BARNARD, JR.E.I.C.,
Secretary-Treasurer

W. A. H. FILER, JR.E.I.C.,
Branch News Editor

Corrosion Film Discussed

Members of the Hamilton Branch have expressed interest in having dinner meetings with guest speakers. The first such meeting was held on November 15 when fifty members gathered for dinner and heard R. J. Law, of the International Nickel Co. comment on the company film "Corrosion in Action". There are few products today which are sold in their natural state that is, without some protective coating. The prime material for the purpose is paint. However, there are many conditions under which paint is not applicable, for example, where moving parts are involved in machinery. It is in this field of protection that alloys play an essential role. Nickel is one of the basic corrosion resistant metals. Its main use is in alloys, hence International Nickel is vitally concerned with research to further the application of its product. At Kure Beach, North Carolina, Inco has established a large corrosion testing station where over 25,000 test samples are exposed to marine atmosphere. By observing the reactions of these samples to weathering, facts are obtained which lead to action in research, producing in turn advances in protective coatings.

The three part film covered the nature of corrosion, electrical potential between anode and cathode with the resultant flow of electrons, the origin and characteristics of corrosion current, and finally, passivity or resistance to corrosion, and protective films. The movies were extremely well edited in colour and time-lapse photography was used to great advantage.

J. J. Kelly, branch chairman, presided over the meeting, and A. E. Archibald, executive committee member, expressed the appreciation of the meeting to Mr. Law.

Ladies' Night

The Professional Development Program has another first. A 'Ladies' Night' was held on November 23 at the Royal Hamilton Yacht Club. To insure that the ladies would be invited to attend the dance, a letter was sent by the executive giving details of the event. The response was very encouraging, nearly 100 couples attended and enjoyed dancing, a skit by some of the talented members and a buffet supper. The evening was so successful that it is expected that the Ladies' Night will become an annual event.

The P.D.P. has outlined its constitution in a 16-page booklet which will be dis-

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tributed across Canada as a guide to other programs.

Uranium Development Outlined

The second dinner meeting of the fall program was held on December 13, 1956, with R. M. Way of R. M. Way and Company Ltd., Toronto, as guest speaker. This consulting engineering firm is responsible for seventy-five per cent of the uranium development in Canada. Mr. Way emphasized the importance of Canadian uranium in the world today. With one of the world's largest sources of uranium at Blind River, Ont., Canada will be by 1958 the top supplier of this mineral. The extent of our supply of uranium is indicated by the fact that from 1958 to 1963 Canada will export 350 million dollars worth of U308 to the United States annually. It is felt that the advent of atomic energy will bring about an industrial revolution with new applications of this new form of energy being developed continually. The United States is spending 25 million dollars a month on atomic energy.

Four Main Sources — There are four principal sources of uranium in Canada. These are Beaver Lodge, Northern Saskatchewan, Bancroft, in Ontario, Eldorado in the Northwest Territories and Blind River, near Sault Ste. Marie, Ont., where 33,000 tons of ore are mined a day. The cost of refining the ore is tremendous, one ton of uranium U308 ore is worth $10.00 and one pound of pure uranium costs $5200.00.

In Canada today the ore is mined, crushed and ground, and leeched with caustic soda or sulphuric acid. This ore is then shipped to the United States where it is refined to produce pure uranium.

This subject "Canadian Uranium Developments" is a topic of vital interest and much of the information has been released only in the past month. Mr. Way is an authority in this field and

A joint dinner meeting of the Eastern Townships Branch and the Corporation of Professional Engineers of Quebec was held at Sherbrooke, Que., on Friday, Nov. 23, 1956. Among those attending were, left to right; A. Crepeau, G. Piette, G. M. Dick, J. Bourque, Leo Roy, G. Masse, and J. Lemieux.

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provided a very interesting and informative evening.

J. J. Kelly, branch chairman, presided over the meeting and H. E. Seely, executive committee member thanked Mr. Way on behalf of the forty members in attendance.

LETHBRIDGE

R. J. D. GARDNER, JR.E.I.C.,
Branch News Editor

R. D. HALL, JR.E.I.C.,
Secretary-Treasurer

Dr. L. A. Wright Guest of Honor

A combined dinner meeting and ladies' night was held on November 15 in the El Rancho banquet room at Lethbridge. Dr. L. Austin Wright, general secretary of the Institute was the guest of honor and expressed the regrets of the president, V. A. McKillop, called back from his Western tour in being unable to attend.

He then went on to review the history of the Institute, pointing out that it is the largest society of its kind in Canada, and that the production of the *Journal* is the biggest publishing job of its kind in Canada today.

Commenting on the shortage of engineers, Dr. Wright quoted The Honorable C. D. Howe as saying that there should be a slight shortage of engineers, this being evidence of an advancing economy. The shortage should not, however, be allowed to become too severe.

Although freshman registration in engineering is up 18 per cent this year and overall engineering student registration is up 12 per cent, the demand for engineers still far exceeds the supply. Immigration of engineers, which until recently exceeded graduation, is now dropping of, and this will also contribute to the shortage, which in a few years could reach serious proportions.

Answer to Shortage — The answer to the shortage of engineers, Dr. Wright felt, is the engineering technician. These men, trained in mathematics and engineering design, would release many engineers for more advanced work. Engineering technicians would be easier to train than engineers, but so very few schools offer such a course. It is felt that the provincial governments should institute such courses and thereby materially reduce the present and future shortage of engineers.

During the evening an excellent musical program was enjoyed. This included duets by Temple Sinclair and Mrs. Sinclair, accompanied by Mrs. R. D. Hall, vocal numbers by Miss Ella Findlay, and piano and violin numbers by George Brown and Mrs. Brown.

Another guest of the evening was Mayor T. R. Haig, who welcomed Dr.

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Wright to Lethbridge. Dr. Wright was introduced by N. H. Bradley and thanked by E. A. Lawrence.

Branch chairman A. J. Branch presided at the meeting, and R. D. Hall introduced guests.

MONCTON

V. C. BLACKETT, M.E.I.C.,
Secretary-Treasurer

Engineers' Wives Association

The first meeting of the Engineers' Wives Association was held recently at the home of Dr. and Mrs. G. T. Leighton.

The thirty-four members present were welcomed by Mrs. Wickwire, wife of R. M. Wickwire, chairman of the Moncton Branch, who announced that the slate of officers will act until the annual meeting next May.

Elected president was Mrs. M. F. K. Leighton; vice-president, Mrs. G. Peck, and secretary-treasurer, Mrs. V. C. Blackett.

In addressing the members Mrs. Leighton spoke of the activities of wives' associations active in the Maritimes at St. John and Halifax, and outlined plans for the coming season.

Highlight of the evening was a film entitled 'Iceland Today'. Later, bridge was played and refreshments served.

NORTHERN NEW BRUNSWICK

V. G. MACWILLIAM, JR.E.I.C.,
Secretary-Treasurer

BERNARD BEATON, JR.E.I.C.,
Branch News Editor

F. M. Ross Addresses Meeting

The December meeting of the Northern New Brunswick Branch of the Engineering Institute of Canada was held in the New Florence Hotel, Campbellton, N.B., on Saturday, December 8. Engineers from Northumberland, Gloucester and Restigouche Counties were in attendance. The meeting which included a short business session was presided over by the chairman of the Northern New Brunswick Branch, A. R. Bonnell.

Guest speaker for the evening, F. M. Ross, supervisor of the pilot plant in the Restigouche Co. Ltd. research department at Atholville, was introduced by V. G. MacWilliam. He gave a very interesting talk on the operation and control of pulpwood processing and described, with supporting graphic tabulations, some of the projects that are being studied in this department. His topic was a familiar one to many of the engineers in this area who are associated with the pulp and paper industry.

A buffet lunch was served during the discussion period which followed.

OTTAWA

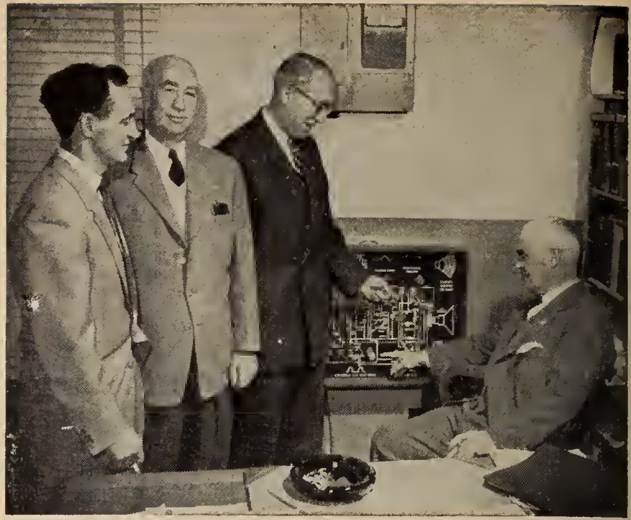
S. G. FROST, JR.E.I.C.,
Branch News Editor

President Visits Ottawa

Young engineers rise to responsible positions more quickly in Canada than in the United States. This encouraging news was revealed by president V. A. McKillop to the engineering students of the University of Ottawa and Carleton College during his visit to the Ottawa Branch on December 6, 1956.

Accompanied by Assistant General Secretary E. C. Luke and later joined by the General Secretary Austin Wright, President McKillop was introduced to the many activities of the local branch

during his brief visit to the nation's capital. After speaking to the students of the two local engineering schools the president held a press conference and attended a regular luncheon meeting of the Branch. In the afternoon he sat in on a meeting of the management committee and, with Mrs. McKillop, joined the committee members and their wives at supper. Later in the evening he met and addressed the general membership of the Branch at a reception.



During the president's visit to the University of Ottawa, vice-Dean Dr. R. U. Lemieux, Col. W. P. Pennock, Branch chairman, and Mr. McKillop, standing, chat with Professor R. H. Galbraith.

Engineering Future in Canada — President McKillop met with Vice-Dean Dr. R. U. Lemieux and Professor R. H. Galbraith at the University of Ottawa. Speaking to the engineering students in the auditorium of the new medical building, he told them to look to Canada if they aspired to a real future in engineering. Jean Belanger, speaking on behalf of his fellows, thanked the president for his interest in their future.

Carleton College — Dean S. G. Takaberry and Professor E. E. Goldsmith welcomed the president to Carleton College. This was the seventh group of students that the president had addressed during his term of office and he urged them to aim high, but with true perspective, when planning their career in engineering. G. C. Langdon, student, introduced the president and M. Ross Jackson, also of the student body, moved a vote of appreciation.

The president was accompanied on his visits by Col. W. B. Pennock, Branch chairman, and Stewart B. Frost, vice-chairman of the Junior Section.

Canadian Shipbuilding — Richard Lowery, president of Davie Shipbuilding Limited, painted a gloomy future for Canadian Shipbuilding in his luncheon address to the Ottawa Branch. Without federal government help and assistance he warned that shipbuilding in Canada could not be maintained virile and ready for the emergency of war.

Mr. Lowery pointed out that our coasting trade must be restricted to ships owned and built in Canada. This would prevent vessels of U.K. registry, with their lower operating and capital costs, from competing with our own ships. The deepening of the St. Lawrence would under our present policy of free trade, deal a crippling blow to Canadian Great Lakes shipowners and to the builders of their ships.

With Mr. Lowery at the head table was President McKillop who spoke briefly. Other guests of honour were Mrs. E. M. Lett, executive secretary of the Canadian Shipbuilding Association, L. C. Audette, chairman of the Canadian Maritime Commission, and Rear Admiral W. W. Porteous, chief of Royal Canadian Naval Technical Services. Mr. Lowery was thanked by B. G. Ballard past vice-president of the E.I.C.

Supper at Chateau Laurier — At an informal supper in the Canadian Grill of the Chateau Laurier, the president and Mrs. McKillop dined and danced with the wives and members of the Ottawa Branch management committee. Following the supper the group proceeded to the R.C.A.F. Officers' Mess where Mr. and Mrs. McKillop received the members of the local branch. In his address the president commended the Ottawa Branch for its most active part in erecting the memorial to Colonel By.

Mr. McKillop advised that engineers might be better guided in choosing their way of life by asking themselves what other people want rather than what they want themselves. He pointed out that as employees (97 per cent) we tend to concern ourselves only with technical matters and leave the social implications of our work to employers and politicians.

Shown enjoying the reception held in Ottawa are, left to right: Col. W. B. Pennock, Ottawa, Branch chairman, Mrs. V. A. McKillop, Dr. Austin Wright, General Secretary, Mrs. Pennock and President McKillop.

SAULT STE. MARIE

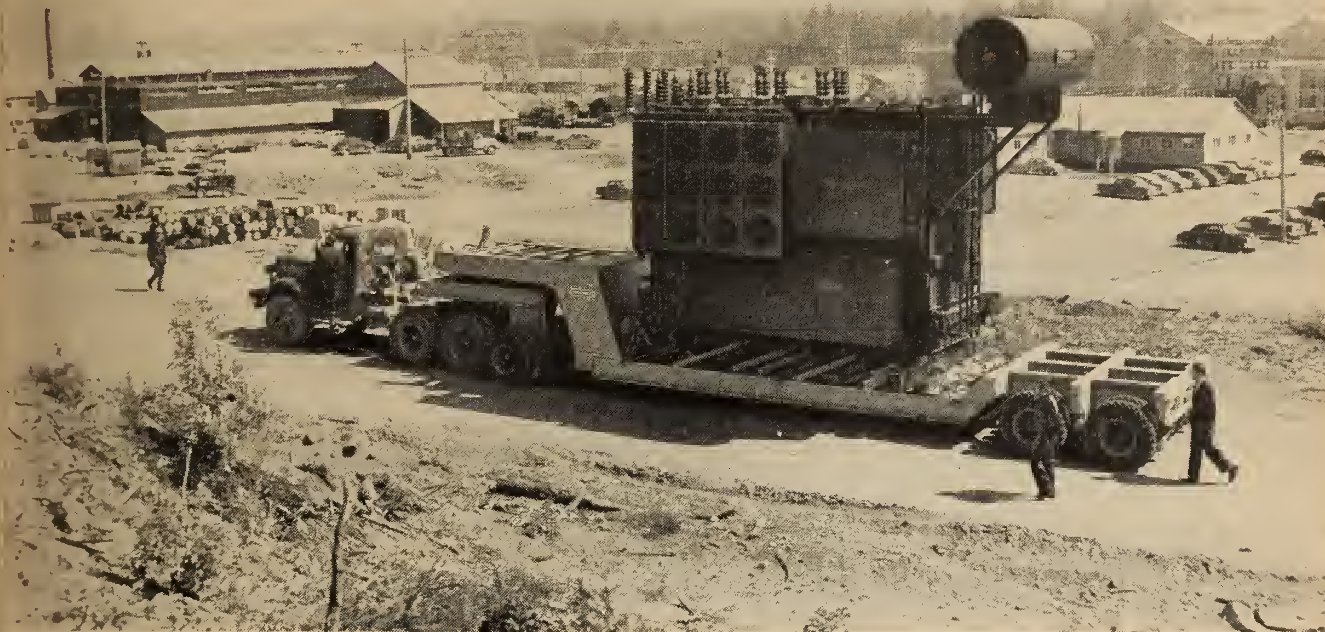
L. F. MASON-TULBY, M.E.I.C.,
Secretary-Treasurer

Mackinac Straits Bridge Construction

Guest speaker at the November meeting of the Branch was J. W. Kinney, resident engineer for the Mackinac Straits giant bridge construction project, representative for the State Bridge Authority, and for Dr. D. B. Steinman, the designer and consultant.

Introduced by L. Mason-Tulby, secretary-treasurer of the Branch, the speaker gave an interesting technical address on the second phase of construction of the giant Mackinac bridge, starting after virtual completion of the abutments, piers and anchorages, and covering erection of the great towers, a large proportion of the approach spans of structural steel, and the threading across and spinning of the huge steel cables for the central suspension span.

The address was graphically illustrated with coloured slides, and some interesting and unusual features of design emerged. As a matter of interest some broad comparisons were made with the famous Golden Gate bridge at San Francisco. Whereas the central suspension span of Mackinac is 3,800 feet, being shorter by 400 feet, the total bank-to-bank gap of four miles here involves a



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greater total of approach spans. Furthermore the gulley is much deeper, which posed special engineering problems.

While the San Francisco structures incorporates eight lanes, including railroad lanes, the Mackinac Bridge has only four lanes, without railways but with provision for their future inclusion. *Design for Safety and Stability* — For the sake of lightness, easy snow clearance and greater stability under wind loads, the two inner roadways are to be of open grating, with serrations to ensure good traction. In such matters a new bridge presently under construction benefits by the elimination of undesirable factors, and the inclusion of advantageous features culled from experience. As is now becoming widely known, the outstanding design of Dr. Steinman includes some most important features for safety and stability, such as the system of cross-bracing which is being employed.

After covering the technical field, Mr. Kinney added a few facts of general interest. At any one time the number of men on the site reaches one thousand. The present target date for completion of the bridge for actual passage of traffic is November 1957. To cover the cost of this structure the bond issue is $99,800;000 and the expected toll charge will be similar to the present ferry charge. In regard to maintenance, the State Bridge Authority has undertaken to contribute around $400,000 annually.

Accompanying Mr. Kinney to the Branch meeting were Mr. Bell, assistant public relations officer for the Mackinac Bridge Authority and also Mrs. Kinney and Mrs. Bell.

SUDBURY

H. M. WHITTLES,
Secretary-Treasurer

H. F. COFFIN, JR.E.I.C.,
Branch News Editor

H. D. Hamilton is Speaker

The regular monthly dinner meeting of the Sudbury Branch was held on November 15 at the Granite Club with about 30 members present.

The guest speaker, H. D. Hamilton, manager of Electrical and Silastic Sales for Dow-Corning Silicones Limited, was introduced by E. Savage. Mr. Hamilton's subject was "What's the Silicone".

Mr. Hamilton had given this lecture at Belleville on November 12, and since it is summarized in the Belleville Branch report, January issue, it will not be repeated here.

Telephone Switching Systems

The December meeting of the Sudbury Branch was held in the Legion Memorial Hall, Sudbury, Ont., on December 6, 1956. About 25 members attended.

Guest speaker of the evening was R. W. Vowcott, equipment engineer of the western area of the Bell Telephone Company, who spoke on "Telephone Switching Systems". Mr. Vowcott outlined the progress made in telephone systems from the magneto party line to the present step-by-step dial systems, with the aid of slides. The manual boards were restricted in capacity so that in the larger centres they have been replaced by automatic equipment which performs all the functions formerly done by operators.

The speaker went on to describe the crossbar system that is just coming into use. It is an improvement over the step-by-step dial system in that less equipment is required to do the same amount of work and hence less maintenance and office space.

Mr. Vowcott also discussed the Electronic Switching System being developed to make possible long distance sta tion to station dialing without the assistance of an operator. He concluded his talk by saying, "All this progress has gradually come about because of the telephone company's desire to give better and increased service at the lowest cost."

The speaker was introduced by T. C. Robertson and thanked by W. Ibbotson.

TORONTO

L. F. BRESOLIN, JR.E.I.C.,
Secretary-Treasurer

A. C. DAVIDSON, M.E.I.C.,
Branch News Editor

Report on Seaway Progress

About seventy members and guests heard D. M. Ripley, JR.E.I.C., give a report on seaway progress at a meeting held December 6, 1956. Mr. Ripley, the senior assistant engineer for hydraulics of the St. Lawrence Seaway, was introduced by Lance Farrand, of the Toronto Branch.

The report was as up to date as Mr. Ripley could make it. He had obtained a number of aerial views of the work about three weeks previously which greatly enhanced the exposition.

Halfway Mark Reached — Mr. Ripley, who listed a great many interesting facts about the seaway reported that the seaway was at about the halfway mark. At present the construction was in the most interesting stage. Variius parts were still evident, but would soon be hidden by ponded waters or earth dikes.

Some $160,000,000 worth of contracts had been awarded in the Canadian works of which $45 million were complete. American totals were $13 million and $74 million respectively.

It was interesting to note that views of the construction of the compensating channel at Cornwall, had just been released that evening. This compensating channel would make Cardinal a deep water port, and retain water on the Canadian side of the river, which would otherwise be diverted by the American works. The presence of the channel would also make construction of an all Canadian seaway comparatively easy.

To be Ready in 1959 — It was hoped that the seaway would be completely finished in 1959. A 14-foot channel would be ready in 1958 with power being produced.

Necessity of Iroquois Dam — In the discussion a point was made clear concerning the necessity of the Iroquois dam. Mr. Ripley pointed out that for one thing, the dam was necessary because it separates two ice forming regions in the river; for another, the Iroquois dam would be in operation before the downstream structures were finished and would therefore control the river level during the construction. The power house forebay would be at elevation, 238 for some 10 years, so the head at Iroquois would be perhaps 7 feet.

Thanks for a most interesting paper were tendered by E. R. Davis.

Talk on Semi-Conductors

On November 2, Professor V. G. Smith of the University's electrical engineering department spoke before an audience of sixty members, at an evening meeting held in the mechanical building, University of Toronto. The talk was intended for those who know the fundamentals of electrical phenomena, and was eminently successful in making clear exactly how the transistor or semi-conductor works.

History of Phenomena — Professor Smith traced the history of phenomena connected with semi-conductors, from Faraday's experiment with the negative temperature co-efficient of Silver Sulfate, to the transistor itself which appeared in commercial form in 1946.

Professor Smith dwelt for some time on the underlying electronic phenomena. In summing up, he told of the applications of semi-conductors where weight and space are at a premium, such as in aircraft and in hearing aids, to contrast two extremes.

Speculation on Future — It is interesting to speculate on the future of the semi-conductor. Even now the space and weight saving features and the low power consumption are causing a revolution in the field of computer construction.

The thanks of the group was tendered by H. Patterson.

Ladies' Night

On November 8, the annual Ladies' Night was held at the Embassy Club on Bloor Street. A very pleasant informal evening of dining, dancing and conversation was enjoyed by some 200 people. Arrangements for the evening were under the able direction of Tom Denby, and Ross Norgrove. The Branch chairman, Ken Tupper, made everyone welcome, and helped materially to promote the informal atmosphere of the evening.

R. L. Hearn is Speaker

Dr. Richard L. Hearn, M.E.I.C., of the Hydro Electric Power Commission of Ontario addressing members of the Joint Committee of the E.I.C. and the I.C.E. in Cody Hall, at the University of Toronto, November 13, spoke on the subject, "The Sir Adam Beck Generating Station No. 2, A Major Canadian Hydro Electric Development". An interesting evening was spent by an audience of fifty people who learned of some of the ingenious arrangements in the design of the development. The hydraulics of the canal cross-over were an important feature of the whole scheme. Other phases of the design were of considerable interest also, notably the curtain of air bubbles used to protect the headrace of the existing station during blasting.

Program of the Joint Area Committee

The 1956 program concluded on December 13 with a paper on "Engineering Aspects of Municipal Subdividing", by M. Couse, Jr. E.I.C., chief engineer, Scarborough Branch, Proctor, Redfern and Laughlin.

Meetings were scheduled for Feb. 7 and March 7. A paper on "Planning for Future Highways in Ontario", was given by W. J. Fulton, Dir. of Planning, Dept. of Highways of Ont. "Application of Computing Machines to Civil Engineering Design Problems" is to be given in March.

April 4, 1957, will be an "Open Night". For this occasion, original papers of civil engineering interest are invited. Any member wishing to present a paper should write the Secretary; B. Hardcastle, c/o McColl Frontenac Oil Co. Ltd., 8 Spadina Road, Toronto, Ontario.

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VANCOUVER

A. D. CRONK, JR.E.I.C.,
Secretary-Treasurer

T. F. HADWIN, M.E.I.C.,
Branch News Editor

Miles Green Presents Paper

On November 28, 1956, the Vancouver Branch heard a paper presented by Miles Green, chief engineer of the North West Telephone Company, entitled, "The Trans-Canada Micro Wave System". The paper has been summarized by S. S. Lefeaux, Branch chairman, as follows: "Mr. Green described in general terms the construction of the trans-continental micro wave system which will carry simultaneously three television programs and hundreds of telephone conversations when completed. The British Columbia section of the micro wave system will be the final line to be put into operation and should be completed in the fall of 1957. Mr. Green illustrated his talk with a most interesting set of coloured slides.

The problems encountered in the selection of route and providing access to the sites for the B.C. section were tremendous.

Surveys were made through the mountains by means of aerial photography and with the use of lights and mirrors.


Miles Green

Provision of access to the sites of the stations proved very costly. An aerial tramway is under construction for access to the station at Hope, B.C., as the cost of road access to this mountainous location proved too costly. Access to the station in Manning Park will be by means of a tracked vehicle over a very rough mountain roadway. Stations must be inspected at least once each week for adjustment and possible repairs. Each station is equipped with a fully automatic generating set and storage batteries, together with public power supply, except in one instance."

Structural Section

A structural section formed within the Branch in 1956 has so far attracted an average of twenty-five to forty members to its meetings. With a promising looking future, the meetings take the form of dinner meetings at which a local speaker delivers a paper on a technical subject in the structural field.

WINNIPEG

C. S. LANDON, M.E.I.C.,
Secretary-Treasurer

W. A. Snodgrass Addresses Electrical Section

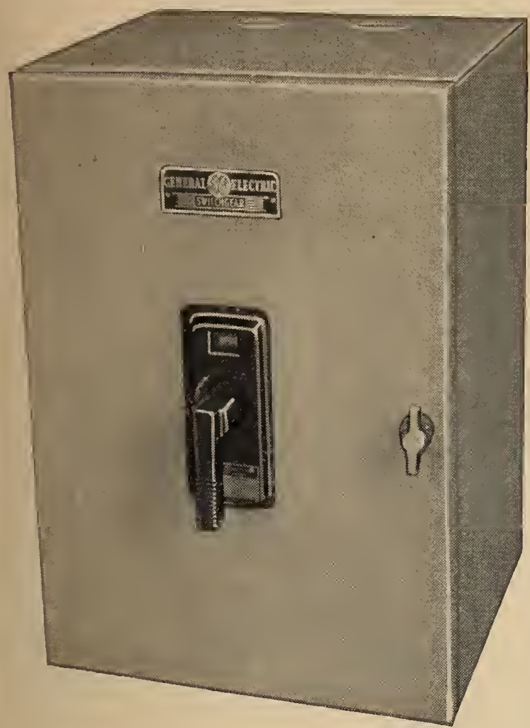
On December 6, the Electrical Section of the Winnipeg Branch was addressed by W. A. Snodgrass, switchgear division, English Electric Co., of Canada on the subject "Circuit Breaking".

Mr. Snodgrass outlined the development of the circuit breaker and discussed the merits of the various types under the broad divisions of bulk oil, minimum oil, magnetic air break and air blast. None of the designs was discussed in great detail but Mr. Snodgrass had obviously selected the illustrations with great care and the result was a concise but very complete coverage of a broad field.

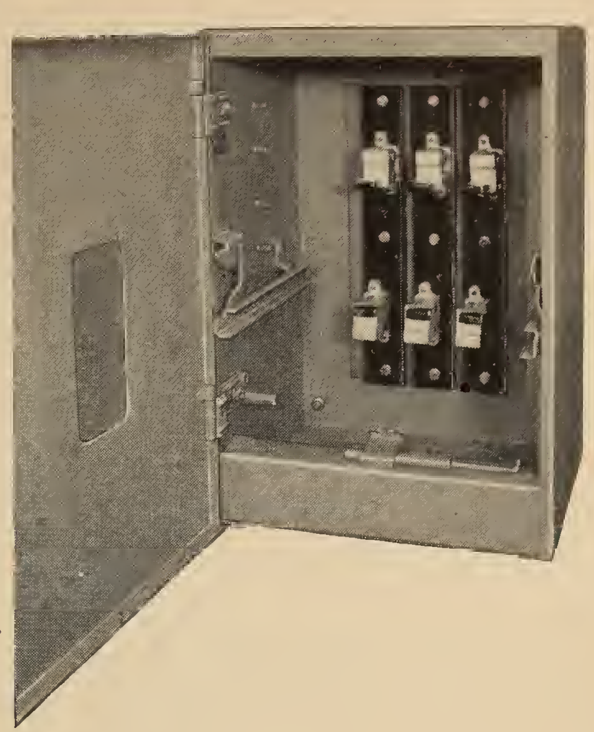
Mr. Snodgrass then discussed various standards relating to the short circuit testing of circuit breakers and outlined the main features of European anc North American procedures in ratin; and testing. The North American prac tice of circuit breaker selection is basec upon an asymmetrical rating, while ii Europe selection is based upon symmet rical rating. Mr. Snodgrass discussed th methods in some detail but suggestec the European method was basically mor logical in its approach.

Film Shown — In conclusion, Mr. Snod grass showed a short film, made with a high speed motion picture camera, whicl showed the action of a low current ar in a magnetic air circuit breaker. Sev eral shots were made, with currents o the order of 50 amperes, with and with out the arc puffer in operation. Withou a puffer, arc extinction was extremel slow, there being insufficient magneti action to force the arc into the arcin chute. With the puffer in operation, th arc was pushed into the chute ver quickly and arc extinction was rapic The arc chute used in the test wa transparent and it was possible to se the way in which the arc was elon gated and finally extinguished. It wa even possible to see the pulsations i the arc corresponding to the 50-cycl frequency.

A lively discussion period followec mainly concerned with the compariso of European and American specification



‹bove is closed view of the type DAK Air Circuit Breaker showing its ‹ompact design and sturdy construction. The single-unit—either manually ‹r electrically operated—eliminates the necessity for a disconnect switch.



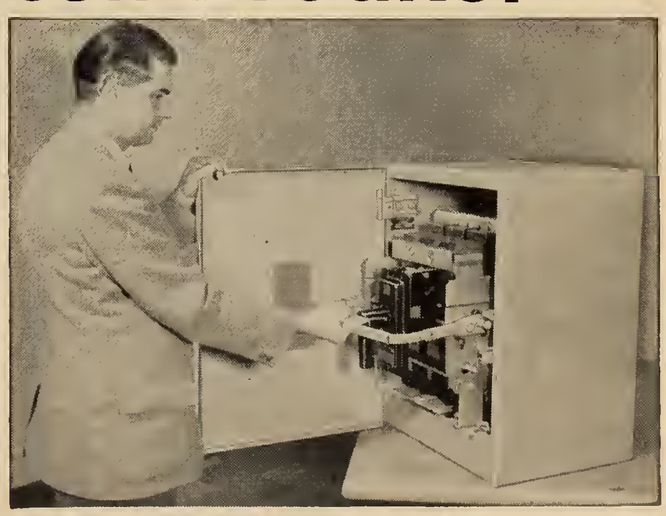
The Wall-mount Housing with the breaker mechanism removed shows clearly the silver-tipped breaker points, and the sturdy splash-proof construction of the housing.

‹LECTRIC Air Circuit Breaker ‹ircuit's broken

tripping devices which do not require current transformers.

This is the first time any electrical manufacturer has offered Canada's mining industry a device for complete circuit isolation in one compact, single unit, and in compliance with the mining code. These breakers are available for either manual or electrical operation. Ratings are available from 15 to 600 amps, with Interrupting Capacities of 15,000 amps, and 25,000 amps.

For further information on ratings, specifications and other data, contact your nearest C-G-E Office or write: Apparatus Department, Canadian General Electric Co. Ltd., 107 Park St. N., Peterborough, Ontario.



The DAK 1-25 Air Circuit Breaker, showing the easy accessibility of all parts, once the breaker is "pulled out". All components are extremely accessible for easy maintenance. Interlock arrangement makes it impossible to draw out breaker mechanism when circuit is closed.

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News of Other Societies

Canadian Geographical Society

President's Letter to Engineers

As a member of the Engineering Institute of Canada, I would like to extend to fellow engineers an invitation from the board of directors of The Canadian Geographical Society to become members of that Society.

Founded in 1929, the Society, a nonprofit organization, not supported by Government, has endeavoured to further its objectives in advancing geographical knowledge and in disseminating information on the geography, resources and people of Canada, through its official monthly publication, *The Canadian Geographical Journal;* through five million reprint booklets purchased and widely distributed by government and industrial clients; through special supplementary publications such as the set of ten booklets entitled "Geographical Aspects of the Provinces of Canada", and "Industry in Action in La Province de Quebec"; and through other educational media such as lectures, the production and sponsoring of documentary films, scholarship awards, etc.

Unique Publication

For those who may not be familiar with the *Canadian Geographical Journal,* a brief word may be of interest: In both form and content this magazine is unique in Canada. Its interest is in every phase — historical, physical, economic and cultural — of the geography, primarily of Canada, but also of the British Commonwealth and the world at large. It seeks to publish articles which are of popular current interest and the greatest care is taken that the information given is dependable and the views expressed authoritative. It is profusely and admirably illustrated and is attractive both to mature and to younger readers.

The society through its *Journal* strives to convey to readers everywhere a true conception of Canada's immense resources and the epic manner of their development, to spotlight practices and research programs designed to effectively conserve and perpetuate renewable resources and stimulate the optimum use of land and water for posterity. In this we feel that the Society shares a joint interest with members of the Engineering Institute of Canada — in fact, that we are virtually the picture window for the work of engineers.

Should you desire fuller information, and I hope you will, regarding the effectiveness of the Society's work, we will be glad to send you statements made in the past few months by our honorary patron, The Governor General of Canada; by Dr. L. W. Brockington; and by members of parliament as recorded in Hansard; as well as a sample copy of the *Journal.*

It is the earnest hope of our directors that members of the Engineering Institute of Canada will accept this invitation to become members of The Canadian Geographical Society. Annual fee for membership is $5.00, and all correspondence and fees should be addressed to the Society at 54 Park Avenue, Ottawa 4.

H. A. Young, M.E.I.C.,
President.

Society for Nondestructive Testing

Activities of the Society for Nondestructive Testing, Inc., in Canada are arranged by two groups, the Ontario and Eastern Canada chapters.

The program of the Ontario Section for early 1957 is as follows: A meeting was held on February 12 in Toronto, which was addressed by Mr. Deans of Canadian Inspection and Testing. His subject was the inspection of the Imperial Oil Building in Toronto.

On March 12 a meeting will be held at the Royal Connaught Hotel in Hamilton, with Dr. McGonnagle, Argonne National Laboratories, as speaker.

There will be another meeting of the Ontario chapter on April 19.

The Eastern Canada Section lists the following meetings for early 1957:

At a meeting on January 17, P. K. Bloch, Branson Ultrasonic Corp., Stamford, Conn., spoke on "Ultrasonic Resonance Testing for Thickness, Measurement and Flaw Detection"; on February 14, S. Rybb, Dawe Instrument Company, Ottawa, discussed "Vibration Measurements".

A meeting will be held jointly with the Canadian Welding Society Montreal Chapter on March 11, at which Dr. W. J. McGonnagle, Argonne National Laboratories, Lemont, Ill., will speak on "Nondestructive Testing of Welds".

In April a meeting will be arranged for a panel discussion. On May 16 Dr. G. H. Tenney, of Los Alamos Scientific Laboratories, will give an address on "International Activities of the Non-Destructive Testing Profession".

The secretariat of the Society for Nondestructive Testing is at 1109 Hinman Avenue, Evanston, Illinois. Information on Canadian groups can be obtained from: J. F. McGuire, M.E.I.C., treasurer for the Eastern Canada section, c/o Racey MacCallum and Associates Limited, 5890 Monkland Ave., Montreal; or P. J. Stewart, secretary, Ontario Chapter, c/o Isotope Products Ltd., Oakville, Ont.

Engineering Centre New York

United Engineering Trustees, Inc., the joint corporate agency of the four major American national engineering societies signed a contract late in 1956 for preliminary architectural plans and studies for a new Engineering Centre in mid-Manhattan, New York.

The new centre will replace the Engineering Societies Building, which houses the four "Founder Societies", the

• Other Societies

American Society of Civil Engineers, the American Institute of Mining, Metallurgical and Petroleum Engineers, The American Society of Mechanical Engineers and the American Institute of Electrical Engineers. A fifth, The American Institute of Chemical Engineers will be included in the Centre project.

The location, cost or time of completion was not announced.

Soil Mechanics Conference

Dr. Karl Terzaghi of Harvard University was guest of honour at the tenth Canadian Soil Mechanics Conference held in Ottawa on December 17 and 18. More than 200 were present, including visitors from the United States, the United Kingdom, India and Burma.

In addition to participating actively in the conference, Dr. Terzaghi spoke at a special dinner held during the conference. He chose as his subject the High Dam at Assouan giving a detailed account of the remarkable design developed for this structure by the International Board of Consultants of which he is a member. He told of the unusual test boring which revealed the deep buried gorge, and of the plans for compacting the dune sand on which the dam is to be built. He expressed the view that, despite all recent political events the dam must be built unless Egyptians in large numbers are to starve.

The Hon. R. H. Winters, M.E.I.C., Minister of Public Works, and Dr. E. W. R. Steacie, president of National Research Council attended this dinner meeting.

The first day of the conference was devoted to landslides in Canada, a subject studied during recent years by a special group under the chairmanship of N. D. Lea. Participating in the discussion were Dr. Nelson Gadd, on the geological aspects; P. M. Bilodeau on the Nicolet slide, with supplementary information by Prof. Jacques Hurtubise and P. A. Rochette; W. J. Eden on a landslide at Hawkesbury, Ont.; Dr. G. G. Meyerhof, on the theoretical aspects of flows; and Dean R. M. Hardy on Landslides in Preconsolidated Clays and Shales. Further examples of landslides were noted by J. D. Mollard, C. F. Ripley, R. Peterson and A. S. Ringheim.

On the second day, M Bozozuk described studies of settlement of structures and R. F. Legget spoke on Soil Mechanics around the World. Sponsor of the Conference is the Associate Committee on Soil and Snow Mechanics of National Research Council, and particularly the Subcommittee, on Soil Mechanics.

It was reported that seven Canadian papers will be submitted to the fourth international conference of the International Society of Soil Mechanics and Foundation Engineering in August of 1957. Progress reports were presented to the Ottawa conference by groups functioning under the auspices of the Associate Committee in many parts of Canada, and by researchers whose work has been supported by grants.

Proceedings of the Tenth Conference will be published by N.R.C. and will be available as a Technical Memorandum of the Associate Committee on Soil and Snow Mechanics. Application for copies should be addressed to the Secretary of the Committee, c/o National Research Council, Ottawa, Canada.

French Chapter of ASHAE

A chapter of the American Society of Heating and Air Conditioning Engineers was inaugurated in Quebec City on December 13, 1956.

Gathering at a special dinner to launch the activities of the new group were engineers and technicians, including the following guests of honour: Guy Dubeau, representing the Illuminating Engineering Society; Dr. Albert Cholette, of Laval University; Louis-Philippe Bonneau, of Laval, chairman of the Quebec Branch of the Engineering Institute of Canada; Lorne Lindsay, past president of the Montreal Chapter of ASHAE; A. V. Hutchinson, executive-secretary of ASHAE; Maurice Paquet, interim treasurer of the Quebec Chapter; R. F. Queer, vice-president, ASHAE; Philippe Lamarche, interim president of the Quebec Chapter; John W. James, of Chicago, president, ASHAE; Jean Veilleux, president of the Quebec Branch, Institute of Power Engineers; John W. Fox, president of the Ontario Association of Professional Engineers; Pierre Bournival, general secretary of the Corporation of Professional Engineers of Quebec; Gerard Venne, vice-president of the Association of Architects of Quebec; W. C. Hole, Montreal chapter, ASHAE; A. DeBreyne, secretary of the Montreal chapter; H. C. S. Murray, Norman K. Smith, and R. J. Kerr, of the Montreal chapter.

Officers of the new Quebec Chapter, numbering 30 members, are: Jean Veilleux, president, Philippe Lamarche, vice-president, Roland Harnois, secretary, Maurice Paquet, treasurer; and directors, L. P. Bonneau, O. Dorval, E. Fournier, M. Royer, and Y. Tasse.

Uniform Traffic Control

The Joint Committee on Uniform Traffic Control Devices for Canada met in Quebec City, on October 5.

J. O. Martineau, M.E.I.C., assistant chief engineer, of the Department of Roads, Quebec, had earlier been appointed as the representative of the Engineering Institute to this Committee.

At this meeting the chairman of the committee, Walter Q. Macnee, reported progress of the plans to develop a uniform system of traffic control devices for streets and highways throughout Canada. It was planned to have a draft uniform manual prepared by April, 1957, with the hope that the manual can be completed at the 1957 annual meeting of the Canadian Good Roads Association.

Reports of the Subcommittees on Signs, Markings, Signals, Islands, Research, and of the French Language Subcommittee, and the Editing Subcommittee were heard. The support of several organizations was reported, including that of the Canadian Federation of Mayors and Municipalities.

Future meetings of the Joint Manual committee are scheduled as follows: on April 22, the day preceding the opening of the convention of the Canadian Highway Safety Conference at the Chateau Frontenac, Quebec; September 28, 1957, a meeting in Saskatoon, after the close of the CGRA convention.

Calendar

Nuclear Congress

The 1957 Nuclear Congress, to be held in Philadelphia, March 11-15, is sponsored by more than 20 engineering and technical societies. It will include a program of two hundred technical papers, two days of conferences for people interested in atomic energy, and an International Atomic Exposition, where new developments related to peacetime nuclear operations will be displayed. The Engineers Joint Council is coordinating the program.

More than forty major topics will be considered, including nuclear generating stations, reactors for ship propulsion, disposal of radioactive wastes, production of atomic fuels, legislative and legal problems, atomic energy developments abroad, and practical commercial applications of the atom in such fields as chemical production and food processing.

Copies of the advance Congress program may be obtained by writing to the Engineers Joint Council, 29 West 39th St., New York 18, N.Y.

Niagara Conference of IES

Joe Thomas, regional vice-president of

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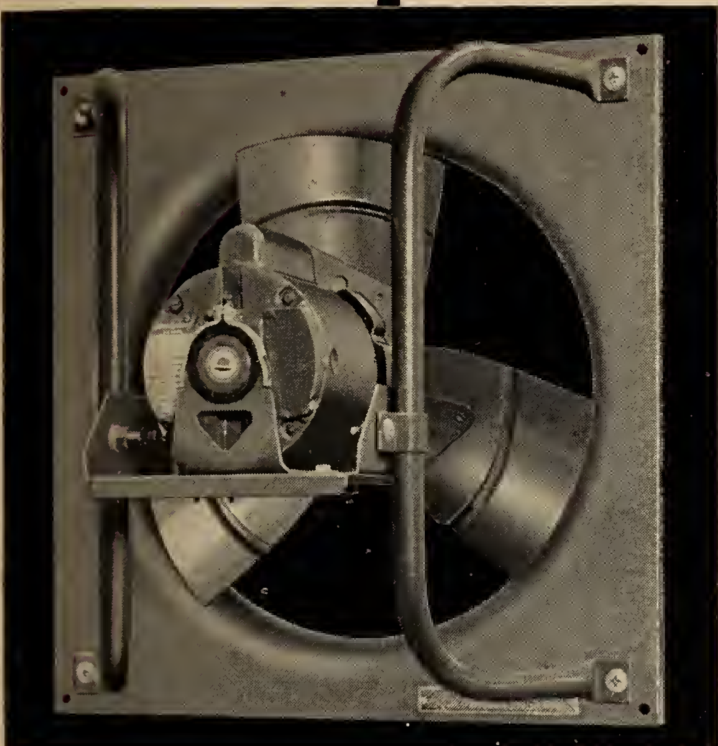

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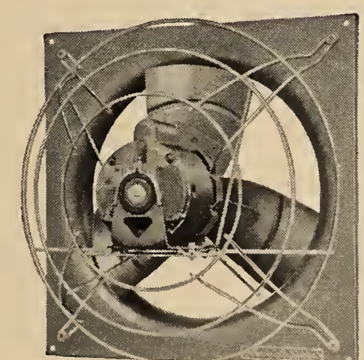

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Model G, at left, is a sturdily built and attractive fan suitable for light industrial duty and commercial applications. It is especially quiet-operating, making it ideal for offices, stores, and lobbies—or wherever quiet operation is required.

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the Illuminating Engineering Society, announces that the fourteenth Canadian regional conference of the Society will be held in the city of Niagara Falls, Ontario, on May 16 and 17, 1957. The host society will be the Hamilton chapter, under the general direction of John H. Mills, general conference chairman.

The conference will include papers by well-known illuminating engineers from Canada and the United States, dealing with such subjects as new light sources, progress in lighting, and other pertinent technical papers.

L. K. Hart, of Canadian Westinghouse Company Limited, (P.O. Box 510, Hamilton, Ont.) is in charge of public relations and information.

Corrosion

The thirteenth annual conference and exhibition of the National Association of Corrosion Engineers (1061 M and M. Bldg., Houston 2, Texas) will be in the Kiel Auditorium, St. Louis, Mo., March 11-15, 1957.

Timber Construction

The convention and annual meeting of the Canadian Institute of Timber Construction (Ottawa 4) will be held at the Hotel Vancouver, Vancouver, March 25-28, 1957.

Mechanical Engineering

Meetings of the American Society of Mechanical Engineers (29 West 39th St., New York 18, N.Y.) are scheduled in the first half of 1957 as follows; Nuclear Congress (in association with the Engineers Joint Council), March 10-16, Philadelphia; Gas Turbine Power Conference, March 18-21, Detroit; Engineering Management Conference, March 27-28, Pittsburgh; Spring Meeting, April 8-10, Birmingham, Ala.; Instruments and Regulators Conference, April 7-10, Chicago; Railroad Conference, April 25-26, Chicago; Management-SAM Conference, April 25-26, New York; Wood Industries Conference, May 16-17, Winston-Salem, S.C.; Oil and Gas Power Conference, May 19-23, Louisville, Ky.; Design Engineering Conference, May 20-23, New York; Semi-annual Meeting, June 9-13, San Francisco, Calif.

For the Gas Turbine Power Conference in Detroit, March 18-21, the program will deal with a number of aspects of gas turbines including automotive use. Among the speakers will be representatives of European automobile manufacturers. An exhibit will display new developments in gas turbines.

Tool Engineering

Information is available from the American Society of Tool Engineers (10700 Puritan Avenue, Detroit 38, Mich.) about the silver anniversary convention and annual meeting. It will be at Houston, Texas, March 23-28, 1957.

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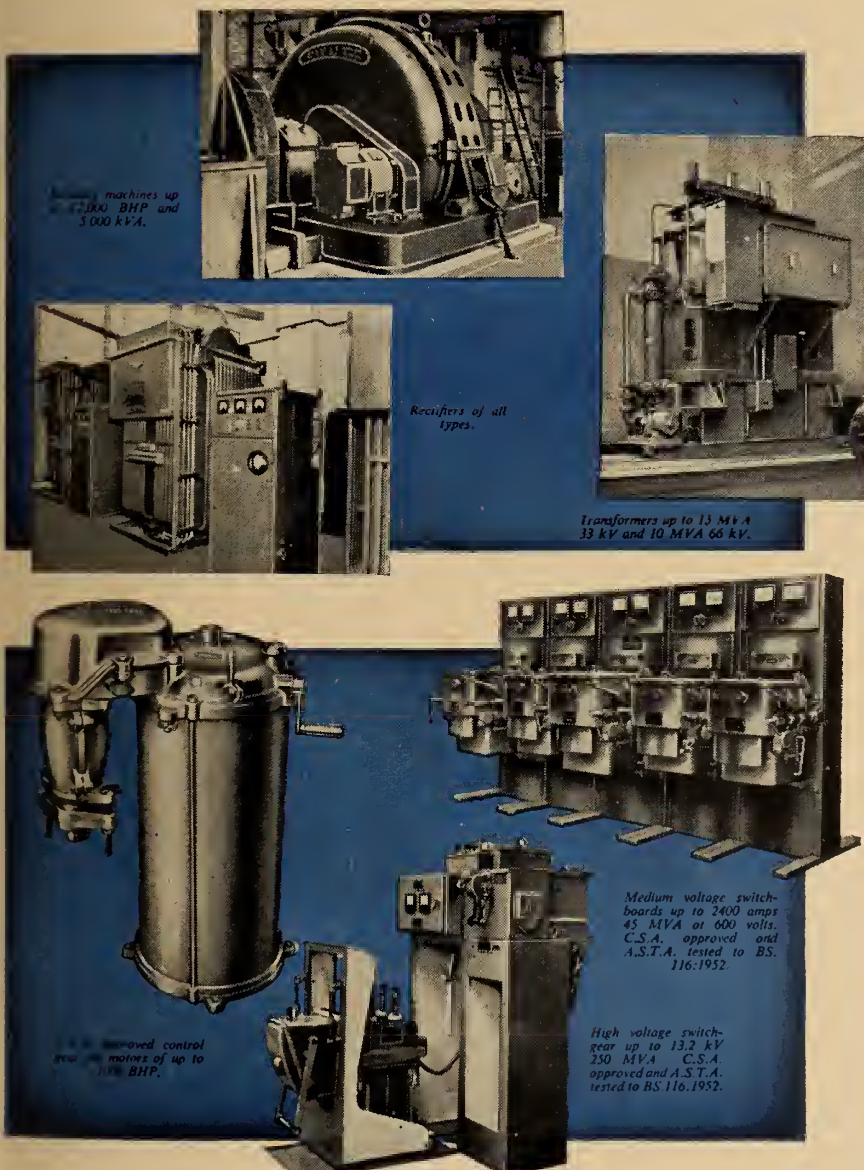

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Library Notes

Additions to the Institute Library
Reviews, Book Notes
Standards

BOOK REVIEW

Records and research in engineering and industrial science, 3rd ed.

J. E. Holmstrom. Toronto, British Book Service, 1956. 491p., $10.25.

The flood of technical information appearing in books, periodicals and individual reports often serves as a deterrent rather than an inspiration to the engineer in search of data on a problem in which he is interested. With such a multiplicity of sources, he is usually at a loss to know where to begin his search.

The aim of this book, now in its third edition in sixteen years, is to bring some order into the apparent confusion, and serve as a guide to the available resources — reports, translations, abstracts, indices, libraries and institutions.

The first three chapters discuss research methods, the relation of science and technology, the classification of the sciences, including a very interesting chart showing some of the relations between the various branches of science and technology.

The following three chapters discuss the various organizations, societies, institutions, government and industrial research bodies, etc., connected in any way with research and/or the propagation of the information resulting therefrom. The chapters cover British organizations, those elsewhere in the world, arranged by country and international oganizations.

Various types of records are discussed in the seventh chapter ranging from note-taking to reference books. The many bibliographical aids available are covered in the next chapter. These include indexes of all types, abstract services, book reviews, etc.

The final chapter deals with the actual procuring of books, periodicals, etc., and their organization so that they may be fully utilized. There is an extensive bibliography, keyed to the different chapters.

This is a most valuable work, concerned wholly with engineering and scientific material, and should be in the library of every engineer.

S.C.

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS

Monday to Friday

9 a.m. — 5 p.m.

Saturday 9 a.m. — 12 noon.

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada.

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

***The aerothermopressor.**

A. H. Shapiro. Nottingham, University, Departments of Civil and Mechanical Engineering, 1956. Various paging, $10.00.

The first lecture in this series of five lectures is a survey of the principles of one-dimensional gas dynamics necessary for an understanding of the Aerothermopressor, a device for atomizing water into a high-speed, hot stream of air, with the objective of realizing the rise in stagnation pressure which is theoretically possible. The second and third lectures are summaries of the theoretical and experimental work done on the device. The last two lectures deal with a deceleration probe for measuring properties of a droplet-laden gas stream, with the evaporation of a cloud of particles of non-uniform size.

Analysis of bistable multivibrator operation; the Eccles-Jordon flip-flop circuit.

P. A. Neeteson. Eindhoven, Philips, 1956. 84p., $2.15 (U.S.)

Written for a doctor's degree in applied physics at the Technical University, Delft, this thesis presents a thorough analysis of the dynamic behaviour of the bistable multivibrator which plays such an important role in electronic apparatus. This is the first such analysis to be published, although the Eccles-Jordon flip-flop circuit was conceived in 1919. The book also contains a summary of previous papers written on the subject.

Analysis of deformation. v. 3, Fluidity.

Keith Swainger. Toronto, British Book Service, 1956. 266p., $11.10.

The first two volumes of this work covered the mathematical theory and experiment and applied theory connected with the analysis of deformation. This present volume considers the fluidity aspects of the deformation problem under the headings of mathematical and classical mathematical formulation; viscous, plane flow; three dimensional, viscous flow; stress fluidity; and boundary conditions and their influence on the flow. Apendices cover vector analysis and rigid body motion.

The author has kept the use of mathematics to a minimum, although mathematical expressions are essential to the representation of the analysis of deformation. The work is based on standard histories and texts, and on periodical articles and other original reports. The author has listed his sources in a bibliography.

***Biological treatment of sewage and industrial wastes. v.I. Aerobic oxidation.**

J. McCabe and W. W. Eckenfelder, eds. New York, Reinhold, 1956. 393p., illus., $10.00 (U.S.)

The thirty-three papers contained in this volume are arranged in four parts

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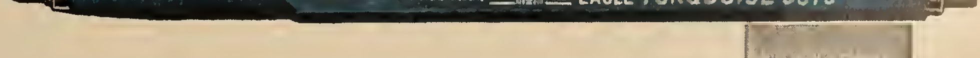

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Part 1 reviews the basic pinciples of bio-oxidation and discusses their application to waste treatment processes. Part II describes the mechanism of oxygen transfer and its application to the design of aeration equipment. Parts III and IV deal with the design and operation of typical biological processes for the treatment of municipal and industrial waste waters. Pulp and paper, dairy, pharmaceutical, petroleum, and cannery waste treatment methods are discussed in separate papers.

***Chemical engineering practice. v. 1, General; v. 2, Solid state.**

H. W. Cremer and T. Davies, eds. Toronto, Butterworth, 1956. 494p., 632p., illus., $13.30 each.

These are the first two volumes of a twelve - volume reference work which will deal with the various stages of chemical manufacturing processes from the laboratory to the completed factory, emphasizing, throughout, the underlying physico -chemical principles. Volume 1 contains brief discussions of the origins and nature of the chemical engineering profession, and deals fully with the economics of production, production planning, pilot plants, and flow diagrams. Volume 11 covers basic solid state theory, metals and alloys, corrosion, powder metallurgy, and porous masses. Considerable space is devoted to the uses of porous masses in filtration, purification of coal gas, water and sewage treatment, and transpiration cooling. Chapter references are given, and a 16-page bibliography on pilot plants is included in the first volume.

Chemical process economics in practice.

J. J. Hur, ed. New York, Reinhold, 1956. 115p., $3.95 (U.S.)

The papers in this publication are those presented at the fourth Experience in industry symposium sponsored by the American institute of chemical engineers and the University of Pennsylvania. Topics covered include: total initial capital required for a process unit and pitfalls of cost accounting; indirect investment and costs of services attending a processing plant and methods used to distribute them; methods of financing the original cost and operation of a new plant.

The symposium was intended primarily for the young engineer, and the emphasis throughout is on the practical aspects of the subject.

***Contracts, specifications and engineering relations, 3rd ed.**

D. W. Mead, rewritten by Mead and Hunt, Inc., with J. R. Ackerman. Toronto, McGraw Hill, 1956. 427p., $7.80.

The first part of this standard text deals with the training and work of the engineer, factors determining professional success, engineering ethics, and the writing of letters and reports. The second part deals, briefly, with the engineer in various legal situations, (as an agent, as an expert witness, etc.), and, in more detail, with construction by direct employment and by contract; advertising and letting contracts; and contract documents. The last part of the book covers the preparation of specifications for materials, processes, machinery, and engineering work. Forms, as well as a complete set of specifications for a construction job, are included.

***Disposal of sewage and other water-borne wastes.**

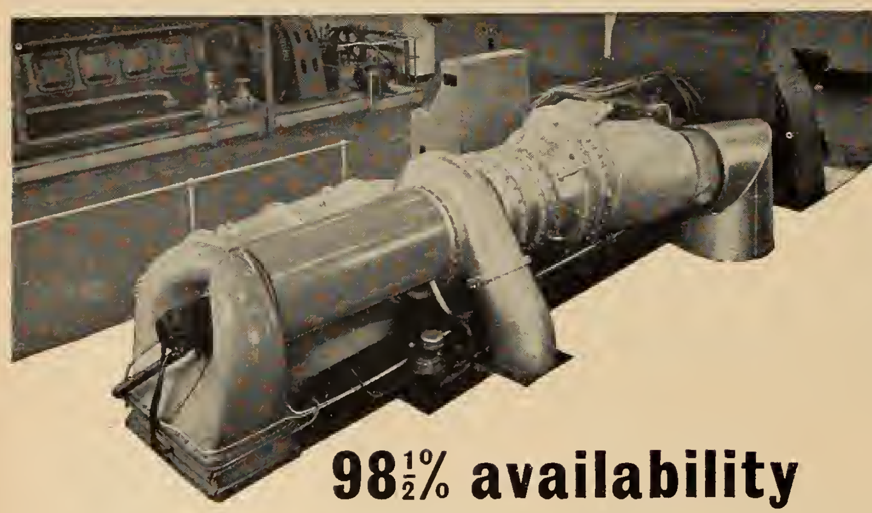
K. Imhoff, W. J. Muller and D. K. B. Thistlewayte. Toronto, Butterworths, 1956. 347p., diagrs., $9.00.

The contents of this book differ from the original German work by Imhoff upon which it was based, in the greater emphasis placed on practices common in countries of the British Comonwealth and in America. Intended as a practical manual for engineers and public officials, it deals in detail with techniques for the treatment of all ordinary water-borne wastes, including domestic or municipal sewage and industrial wastes. Brief sections cover basic data, methods of disposal, and disposal and treatment of wastes in unsewered areas.

Electrical engineering (general)

A. T. Dover and others. Toronto, Longmans Green, 1956. 489p., $9.00.

The first of a new series of undergraduate textbooks, this volume deals with the theory connected with electric circuits, instruments, apparatus and materials for use with direct currents, and with alter-



• LIBRARY NOTES

nating currents of power frequencies.

The treatment of magnetic fields is restricted to static fields, and does not cover the movement of electro-magnetic energy in space. Circuits are covered in detail, and the solution of simple network problems is discussed. Measuring instruments, both laboratory and industrial are also considered.

This series, to which the volume **Electrical machines** also belongs, should prove extremely useful to students, as it will concentrate on the fundamentals of the subject.

Electrical machines

A. Draper. Toronto, Longmans, Green, 1956. 346p., $7.20.

An undergraduate textbook intended for the majority of students who will not actually become designers of electrical machines, the book covers the fundamental principles behind their theory and operation which it is essential that those whose work may involve the use of electric machines should understand.

Among the topics covered in detail are the transformer, windings, the magnetic circuit, the induction motor, synchronous generators and motors. D.C. machines, and mercury-arc rectifiers.

Encyclopedia of instrumentation for industrial hygiene.

C. D. Yaffe, ed. Ann Arbor, University of Michigan, 1956. 1243p., illus., $22.50 (U.S.)

Two years in preparation, this large volume contains the information presented at a 1954 Symposium on instrumentation for industrial hygiene, together with descriptions of over eight hundred instruments. The information is divided into seven sections, covering various fields of instrumentation. These are: instruments for measuring air velocity, sound, vibration, ionizing radiations and ultraviolet, visible and infra-red energy; instruments for sampling and analyzing air for contaminants in industrial environments; laboratory type instruments of specific application to industrial hygiene; instruments for atmospheric pollution evaluation.

Each section includes a review of the instrumentation in that area; technical papers on special problems or types of instruments used; description of instruments used in the field.

This volume should prove of particular interest and value to air pollution specialists.

Fatigue of metals and structures.

H. J. Grover and others. Toronto, Longmans, Green, 1956. 399p., illus., $6.50.

The results of a survey conducted by the Battelle Memorial Institute, this volume is intended for the designer or engineer who has a limited practical experience of fatigue problems. It presents a summary of present-day information, and provides references to the published literature on the subject.

Some of the topics covered by the survey are: the nature of fatigue failures; fatigue damage; stress concentrations; effect of size and shape upon the fatigue strength of a part; effect of high temperatures on fatigue strength; methods of using fatigue data in design; methods of detecting and combating fatigue.

°Flow measurement by the differential pressure method, 2nd. ed.

Luton, George Kent Ltd., 1956. 136p., illus., 10/-.

This small book contains simplified orifice tables and related information useful to the oil field engineer, to the engineer in testing equipment, and to the process engineer in measuring piped supplies of water, air, gas, or steam. Although the data apply mainly to ordinary straight iron pipes with non-pulsating flows and of the usual industrial size, one section of the book is devoted to flow under abnormal conditions. The last part of the book is a catalog of the products of the publisher.

°Induction heating practice.

D. Warburton-Brown. New York, Philosophical Library, 1956. 192p., illus., $10.00 (U.S.)

The general principles and specific practical applications of induction soldering, brazing, and hardening are discussed, and detailed information is given on the design of coils, inductors, and handling fixtures. Factors to be considered in selecting the process are also treated, and one chapter is devoted to the design of components for production by the induction heating method.

°Industrial engineering handbook.

H. B. Maynard, ed. Toronto, McGraw-Hill, 1956. Various paging, $17.40.

This comprehensive reference book for practising industrial engineers contains fifty-eight chapters grouped in the following eight sections: the industrial engineering function; methods; work measurement; predetermined-elemental-time standards; wage payment; control procedures; plant facilities and design; and other aspects. The individual chapters, each prepared by an authority in the field covered, deal with a wide range of techniques and functions, including organizing for industrial engineering, process charts; curves and nomographs; planning and measuring maintenance and construction work, product classification, and the preparation of reports.

Maintenance of high-speed diesel engines, 4th ed.

A. W. Judge. Toronto, British Book Service, 1956. 422p., illus., $9.75.

Largely re-written, this new fourth edition also contains many new illustrations to bring the information up-to-date. The new material added includes a chapter on engine testing after overhaul.

Much of the information is based on the practices of leading English manufacturers of engines and equipment, and is mostly concerned with the automobile type of compression-ignition engine. However, the information is applicable to stationary, marine, agricultural, locomotive and tractor engines.

Massivbrucken. Teil 1. Platten und Balkenbrucken.

Hans Unger. Leipzig, Teubner, 1956. 400p., diagrs., 26 DM.

A new text on concrete bridges, this book covers their design in great detail, and includes many diagrams.

The topics covered include pavements, piers, abutments, hinges, supports, etc. There is a bibliography, most of the works listed being in German.

Metallurgical analysis, by means of the Spekker photoelectric absorptiometer, 2nd ed.

F. W. Haywood and A. A. R. Wood. London, Hilger and Watts, 1956. 292p., illus., £2.

The Spekker absorptiometer is widely used in metallurgical laboratories for analysis, and in this book the authors present information on the use of the instrument and on developments in absorptiometric analysis.

The first part of the book considers the role of absorptiometric analysis, and the construction, operation and maintenance of the Spekker absorptiometer.

The second section discusses the methods used in applying absorptiometry to metallurgical analysis of aluminum alloys, copper alloys, steels, magnesium alloys and zinc alloys. There is a useful bibliography.

Future Annual Meetings

★

1957 Banff Springs Hotel, June 12, 13, 14

1958 Quebec, Chateau Frontenac, May 21, 22, 23

1959 Toronto, Royal York Hotel, May

1960 Winnipeg.

Details to be determined

• LIBRARY NOTES

***The metropolitan transportation problem.**

W. Owen. New York, Brookings Institution, 1956. 301p., illus., $4.50 (U.S.)

This is a broad and critical survey covering such aspects of the subject as trends in population and economic activity; the failure of urban planning to take into account the increased use of private vehicles; the decline of mass transportation; current attempts to remedy the situation by expressways, terminals and off-street parking; methods of financing and organizing transportation systems; and city redevelopment. The author sees the solution to the problem in a program combining metropolitan redevelopment and the coordinated utilization of all methods of transportation.

A primer to the automatic office.

William Eustis and others. Westboro, Automation Management, Inc., 1956. 93p., $7.50 (U.S.)

Commencing with its own definition of automation, the authors proceed to show how automation can be applied to all types and sizes of offices, emphasizing that a thorough analysis of the present system should be made before any particular automatic machine is considered, as sometimes manual or mechanical systems prove more economical.

Suggestions are presented for the correct method to use in analysing and solving the problem of whether or not to use automatic machines. There is a history of calculating and accounting machinery, and a description of the workings of electronic computers. Descriptions are given of the various computers available, and examples are given of actual applications of automatic office machines in various fields. A bibliography concludes this useful book on a subject of increasing importance.

***Principles of guided missile design. v. 3, Operations research, armament, launching.**

Edited by Grayson Merrill and others. Toronto, Van Nostrand, 1956. 508p., illus., $11.00.

The major part of the first section of this book is a review of the mathematics of operations research, illustrated by examples of operational analysis as applied to missile performance. The second section deals with important considerations in armament design: target characteristics, warheads, fuses and arming device. This section also discusses problems of systems engineering of particular importance to armament and includes a chapter on testing. The final section covers load analysis and other basic concepts in the design of launchers, the systems concept as applied to launching, launcher mechanisms, and general principles of design.

Progress in semiconductors.

A. F. Gibson, ed. New York, Wiley, 1956. 200p., diagrs., $8.00

The seven articles in this volume deal with recent advances in silicon; the germanium filament in semiconductor research; the theory of the Seebeck effect in semiconductors; the electrical properties of phosphors; the design of transistors to operate at high frequencies; and the photo-magneto and field effects in semiconductors.

This is the first of a projected series of annual review volumes in the field of semi-conductors. It is hoped that these volumes will enable workers in this and allied fields to keep abreast of current developments. It is hoped that the contributors will include specialists from all over the world. Those contributing to this volume are from the United States, England and France.

Spannbetonbau, Teil 1.

Wolfgang Herberg. Leipzig, Teubner, 1956. 286p., illus., 21.80 DM.

This text for students and practising

engineers on prestressed concrete construction commences with an historical introduction covering the last fifty years. Following chapters cover the principles of prestressed concrete, the materials used, and calculations for design.

The author gives a clear picture of the subject, and the value of the book is increased by the many diagrams and tables, and the bibliography.

***Symposium on powder metallurgy.**

London, Iron and steel institute, 1956. 390p., illus., 65/- (Special report no. 58).

The fifty papers included in this volume are presented in four groups covering the manufacture, properties, and testing of powders; the principles and control of compacting and sintering; the manufacture and properties of structural engineering components, and the powder metallurgy of high-melting-point materials. Some of the papers, such as those on manufacturing methods, the powder metallurgy of zirconium, and powders for magnetic applications, are review papers; others deal with specific processes or materials; testing of ceramal materials, porous stainless steel, hot compacting, etc.

Unit operations of chemical engineeering.

W. L. McCabe and J. C. Smith. Toronto, McGraw Hill, 1956. 945p., diagrs., $12.60.

This textbook for junior and senior undergraduates presents unit operations of the chemical process industries, from the theoretical and practical standpoint. The operations covered are: fluid mechanics; transportation of fluids; size reduction; handling of solids; mixing; mechanical separations; flow of heat; evaporation; mass transfer; gas absorption; distillation; leaching and extraction; crystallization; air-water contact operations; and drying.

In the section on fluid mechanics the boundary layer theory is included and used to connect various problems of fluid flow. The less usual operations, for example, adsorption, have been omitted so that the topics at hand would be fully treated, and kept at undergraduate level. There are problems and references at the end of each section.

STANDARDS REVIEWED

A.S.T.M. Standards, American society for testing materials, 1916 *Race St., Philadelphia* 3.

Rubber products

Every ASTM standard relating to rubber and related products is included in this latest compilation. It contains pocessibility tests, chemical tests for vulcanized rubber, physical tests for vulcanized rubber, aging and weathering tests, and low temperature tests. Standards for automotive and aeronautical rubber, packing and gasket materials, hose and belting, tape, electrical protective equipment, rubber coated fabrics, insulated wire and cable, and hard rubber are also included. Various standards for latex foam, sponge and expanded cellular rubber, rubber adhesives, rubber latex, and non-rigid plastics are also to be found in the compilation. Electrical tests, nomenclature and definitions, and general tests are mentioned. In addition, there are in the appendices proposed methods for testing rubber threads. 746 p., $5.75 (U.S.)

British Standards, British standards institution, 2 Park St., London, W.1. Also available from the Canadian standards association.

B.S. 24: Part 1: 1956.
Axles, railway rolling stock material. 4/-.

B.S. 24: Part 4: 1956 – Steel billets, blooms, bars and forgings, railway rolling stock material. 3/-.

B.S. 760:1956—Wire armoured paper-insulated cables for use in mines. 5/-.

B.S. 2737: 1956—Terminology of internal defects in casting as revealed by radiography. 12/6.

B.S. 2763: 1956—Steel wire for ropes. 4/-.

B.S. 2776: 1956—Paper covered rectangular copper conductors for transformer windings. 5/-.

B.S. 2786: 1956—Round hard drawn brass wire for springs. 2/-.

B.S. 2787: 1956—Glossary of terms for concrete and reinforced concrete. 7/6.

B.S. 2A116—Steel pan head bolts (unified threads) for aircraft, 4/-.

B.S. 2A117 — Corrosion-resisting steel pan head bolts (unified threads) for aircraft. 3/6.

B.S. 2A171—Aluminium alloy pan head bolts (unified threads) for aircraft 3/-.

B.S. 2SP 101-104: 1956—Specifications for turnbarrels, tension rods and swaged cable-end connections (unified threads) for aircraft. 5/-.

B.S. G152—A.C. electrically operated horizons for aircraft, 3/6.

Canadian standards. Canadian standards association, National research building, Ottawa.

A8—1956–Specification for masonry cement.

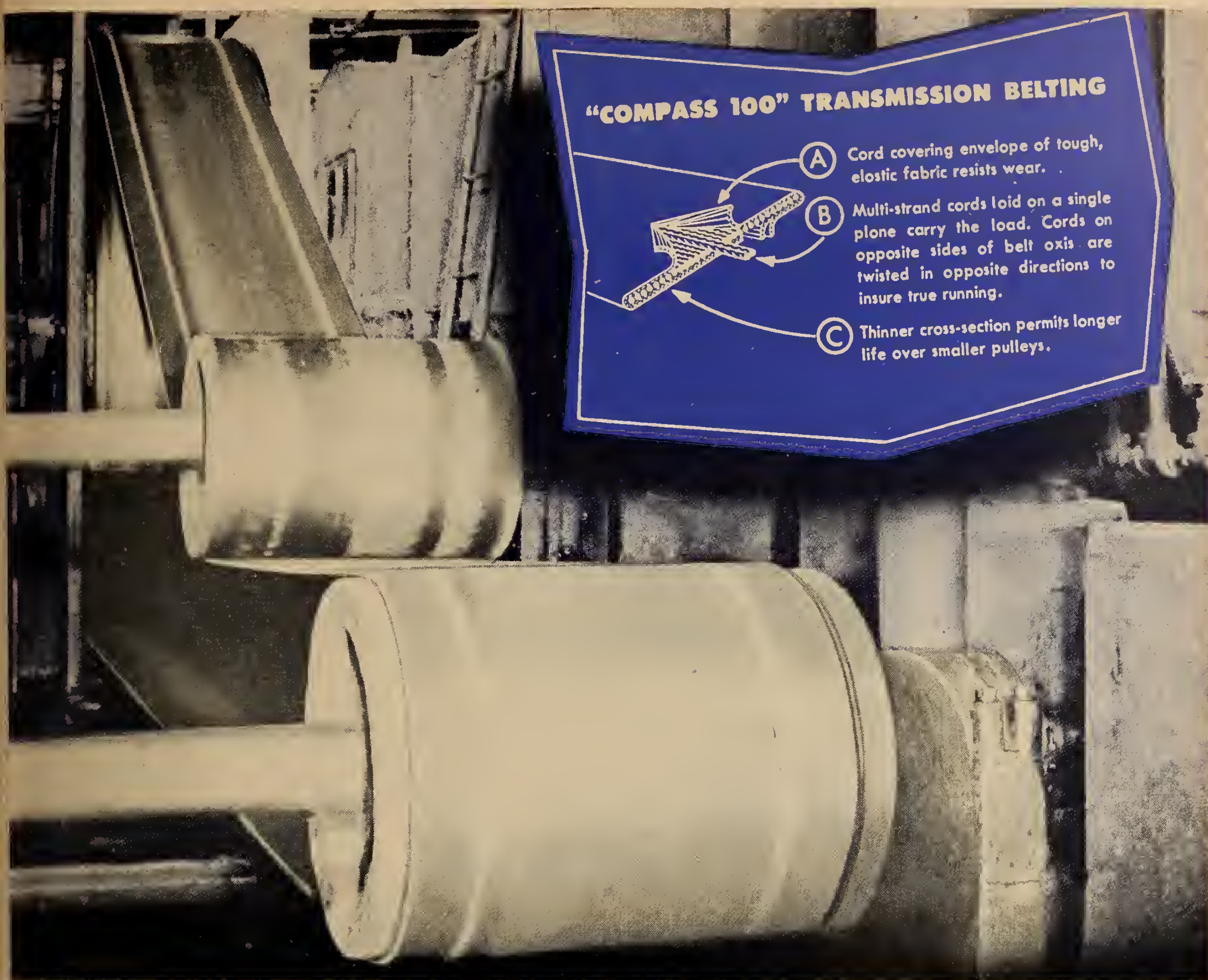
Based largely on the ASTM standard C91-53 (Specification for masonry cement), this specification is written as a performance standard and does not refer to any particular composition of masonry cement, but gives requirements of time of set, strength, soundness, water retention, etc. $1.50

B89.3-1956 — Automobile fire fighting apparatus, 3rd ed.

The third edition includes a number of revisions which have been approved since the publication of the second edition. The specification is intended to cover the minimum requirements and performance of three types of automobile fire fighting apparatus; pumper (triple combination), ladder truck (aerial), and ladder truck and pumper (quadruple combination). It covers the following: provisions applying to all types of apparatus; general construction, carrying capacity, rating of pumpers, fire pump, pump control, booster pump, gasoline engine cooling system, lubricating system, carburetor, ignition, electrical equipment, and other pertinent parts. Acceptance tests regarding pumping and road requirements are also covered. In addition, general information for municipal officials using the specification; conditions of tender and acceptance; and special provisions for all three types of apparatus, have been included. $1.75.

C128—1956—Specification for asbestos-cement conduit.

This specification is intended to include the necessary provisions for the supply and manufacture of a uniformly high quality asbestos-cement conduit. Contents include types, sizes and dimensions, test requirements and procedures, etc. 75 cents.



How belt costs were cut 60%

Belting replacement expense and high maintenance costs plagued management of a Toronto paper processing plant. Transmitting power on a beater drive to agitate 30 tons of reclaimed paper mash, 24 hours a day, 6 days a week at 500 r.p.m. by a 250 Hp. motor, added up to a belt-killing drive.

Troubles ended, however, when a Goodyear Representative stepped in and recommended a "Compass 100" Belt. For 2½ years, this 30" "Compass 100" has successfully absorbed the gruelling punishment of this tough operation.

The cost of "Compass 100" for 2½ years' service was approximately equal to the cost per year of the previous belt.

The Goodyear "Compass 100" Belt now on the job looks like it's going to stay on the job for a long, long time, cutting costs at every turn.

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The Heavy Metal-Fabricating Industries

IN THE DEVELOPMENT of Canada's great natural resources of minerals, forests, water-power and waterways, and in the general industrial expansion, there is needed a great amount and diversity of heavy plant and equipment.

This article deals with the industries that fabricate from iron, steel, and other materials, components and equipment for such fields as hydro-electric and other power plants; mineral, chemical, and petroleum process industries; the pulp and paper industry; shipbuilding, waterways, and port facilities (such as cranes and other materials handling equipment). Many of the organizations that supply these fields also engage in the construction of such structures as bridges, which may be considered here, though the construction industry proper is the subject of a separate article.

Capital investment in the metal-working industries generally has increased greatly in recent years and the expansion of the heavy fabricating industries is likely to continue at a high rate. The reasons are not hard to find and have already been briefly outlined in terms of the country's general development. In particular, mention might be made of such developments as the St. Lawrence seaway, which requires new locks, new or reconstructed bridges, and a wide expansion of equipment associated with inland port facilities.

The power project on the St. Lawrence is only one of many current or planned hydro-electric developments in Canada that will make heavy demands on the industry for equipment. In areas such as the province of Ontario, where industry is growing rapidly, but hydro-electric power is approaching the limits of further expansion, there will be a major increase in thermal power production; this will have to be met by the provision of more facilities for the manufacture of modern high-pressure boilers and associated equipment. Just entering the field, but undoubtedly due to have considerable significance in the country's power economy within a generation, is the nuclear power reactor, which poses special problems for the heavy engineering industry in the design and fabrication of reactor and other pressure vessels, heat exchangers, and other plant.

The growth of the mining industry means the growth of the demand for heavy mineral dressing and handling equipment, extraction, smelting, and processing plant, and so on. The petroleum and natural gas industries, comparatively speaking, are still in their infancy and are already large customers for refinery equipment and great quantities of pipe; though the largest diameters of pipe for gas and oil lines still have to be imported.

Like petroleum, the chemical and other process industries make wide use of pressure and other vessels, pipe, and storage tanks. The pulp and paper industry depends to a great extent on heavy equipment for pulping, processing, and paper-making; this, too, is a continually expanding demand.

These few examples will show that probably the biggest problem that the heavy metal-fabricating industries have to face is the need to keep up with the general growth and to expand their own manufacturing facilities. Not the least of these facilities is the engineer.

Generally speaking, the greatest demand of the industry is for mechanical engineers, though there is some need for engineers in other fields, particularly metallurgical, chemical, electrical and civil. In al

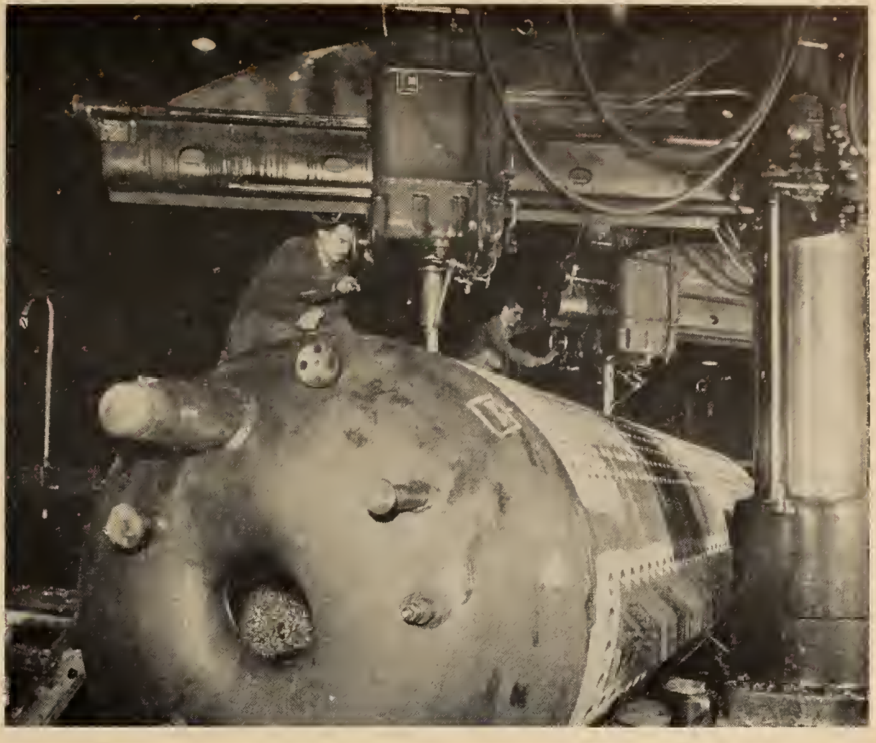
A typical item for the hydro-electric power industry is this Y-piece for a penstock. Large units are often partly shop-fabricated and later assembled in the field.

branches of the industry the prospects for suitable engineers are very good.

Fabricating Techniques

The techniques used by the fabricating industries include forming, by rolling, stamping, forging, and other methods; casting, by a variety of foundry techniques; cutting, which covers a very wide field of machine tool operations (drilling, broaching, milling, etc.); and joining, including the important and growing field of welding, brazing, rivetting, and so on. Some industries specialize in a certain field, for example, in the production of castings or the fabrication of equipment by welding; others employ a variety of techniques in the manufacture of their products.

Considerable engineering development work is involved as new materials are brought into use and new methods of fabrication, or adaptions of the usual methods, are required. An example of this is the increasing use in recent years of stainless steels and other alloys, and the non-ferrous metals, of which the metallurgical properties have to be investigated from the point of view of design behaviour and methods of fabrication.



Several fabricating techniques are used in the manufacture of equipment such as boilers. Here, a large welded boiler drum is being drilled in the machine shop.

Design and Production

As well as the physical expansion of the fabricating industries there must be considered the advances made in the fields that they supply. As capacities of equipment increase and new processes develop, so must the design of the plant and material supplied by the fabricating industries be advanced. Design engineering is therefore an important phase of their operations.

The manufacture of equipment, involving the techniques outlined previously, needs engineering staffs for plant, production, and industrial engineering, and specialists such as welding engineers and tool engineers.

After manufacture, some organizations may provide the engineering supervision for the installation of their equipment in the customer's plant or they may be responsible for a whole project, such as a bridge, from design to final construction. In such cases the industry will have teams of project and structural engineers whose work extends beyond the stages of design and manufacture.

An extension of this, which is so closely associated with the heavy fabricating industries that it may be considered here, is the firm that specializes in the design and construction of part or complete plants for industry (for example, petroleum refineries) though it may not have its own manufacturing facilities. Such engineering companies employ teams of engineers who work from initial design to final installation of equipment in close cooperation with the equipment manufacturers and the final customer, often as residents in the respective plants. These engineers require much the same experience as those who are actually with a fabricator of heavy equipment.

Other Fields

There is quite a wide field for the engineer with other companies which are not specifically heavy manufacturers, yet are very closely associated. These include makers and suppliers of welding equipment who frequently have engineers who can advise the manufacturing industries on the best techniques to use and who work closely with other companies' welding engineers. Similarly, there are firms specializing in foundry techniques or other fields who have suitably qualified engineers, though they do not necessarily themselves engage in manufacture.

Administration and Sales

In this group of engineering industries the only limit to the advance of the individual engineer is his own capability. A very high proportion of senior administrative and top management positions in many companies in this field are filled by professional engineers, who have advanced through various levels of responsibility and supervision.

The sales engineering activities of these industries are also widespread.

Training

Most companies accept engineering students for summer work. There are some that emphasize apprentice training schemes.

For the graduate engineer, the scheme of training varies somewhat with the particular industry, but it is generally designed to give him the basic essential experience followed by any necessary specialized training. This may extend from on-the-job experience to company support of outside advanced courses.

Salaries and Benefits

Starting salaries are generally in line with other major industries. Subsequent advances depend largely on the qualifications of the individual but industry scales are broadly guided by the rates suggested by the provincial associations of professional engineers.

EMPLOYMENT SERVICE

This service is operated for the benefit of members of The Engineering Institute of Canodo ond for industriol ond other orgonizotions employing technically troined men—without charge to either porty. It would be appreciated if employers would moke the fullest use of these focilities to list their requirements—existing or estimoted.

NOTICES appearing in the SITUATIONS WANTED column will be discontinued ofter three insertions. They will be reinstated on request, ofter o lapse of one month.

REPLIES to odvertisements should be addressed to File No. 000, Employment Service, The Engineering Institute of Conada, 2050 Mansfield Street.

INTERVIEWS with the Institute Employment Service, 2050 Mansfield Street, Montreal—Telephone PLoteau 5078—moy be orronged by oppointment.

SITUATIONS WANTED

ELECTRICAL ENGINEER, M.E.I.C., P. Eng. (Alberta) with twenty-five years' selling experience in Western Canada plus some administrative duties desires a wider opportunity for creative effort. Familiar with electrical rotating and static machinery and similar types of equipment. File No. 1854-W.

GRADUATE ENGINEER, M.E.I.C., P.Eng., age 44, married, with family; has substantial experience in home appliance (refrigerator) field. Is seeking position with scope for further growth in refrigeration or allied art. File No. 1958-W.

GRADUATE ENGINEER, M.E.I.C., P.-Eng. (Ont.), B.Sc. (C.E.), UNB '41, age 38, married with one child. Diversified background in structural, heating and electrical design and draughting, preparation of architectural and engineering specifications, and administration of contracts in an architect-engineer firm. Seeking a responsible position with a progressive architect-engineer or consulting firm. Presently employed and available on reasonable notice. File No. 2477-W.

ENGINEER, B.Sc., P.Eng., twelve years' experience, plant, equipment and general engineering, including design, development and layout. Cost estimating, methods, production, maintenance, correspondence and report writing. Presently employed, seeks increased responsibility at administrative level. File No. 2644-W.

ELECTRICAL MECHANICAL ENGINEER. Available for appointment as chief engineer, assistant works manager, or plant engineer. Thorough knowledge of production principles, plant layout and construction, production machinery and plant services. Natural leader with highly successful record established in administration and supervision of engineering and maintenance of large plants. Complete details and references available. Prefer location in Eastern Canada. File No. 2728-W.

MECHANICAL ENGINEER, M.E.I.C., P.Eng., B.Sc., married with children, with 11 years' intensive experience since graduation in the design and construction of utility systems for heavy industries, natural gas distribution, thermal power stations, heat treating furnaces. Experience includes project supervision, contract negotiation, engineering sales. Wishes to associate with progressive capable management as staff member or representative. Your enquiry will bring a prompt reply. File No. 2990-W.

CIVIL ENGINEER, age 34, bilingual, married, presently employed in construction division of large public utility as assistant superintendent engineer, desires position of administrative or supervisory capacity with construction company. Further details on request. File No. 3774-W.

PRODUCTION ENGINEER, Jr.E.I.C., P.Eng. (Ont.) McGill Mechanical Graduate, completed 2/3 of master's degree course in business administration at University of Michigan, age 37, married, holds current commercial pilot's licence. Desires position as head of a production engineering or manufacturing engineering department, or to take charge of production, or both, in a metal working manufacturing plant. Experience includes administrative and supervisory background in the engineering functions of process planning, tool design, plant layout, cost reduction; and also the shop services of tool room, cutter grind, tool inspection, tool cribs and tool procurement. Location not important, with a preference for Ontario or B.C. Presently employed, available on reasonable notice. File No. 3958-W.

SALES ENGINEER, M.E.I.C., age 38, married, presently employed as Sales Engineer in materials handling industry to large industrial concerns. Also, extensive experience in sales, product development, manufacturing, in electrical hardware industry. Seeks connection with medium sized company in managerial position, or interested in partnership in agency dealing with materials handling products to industrial accounts. Preferred location southern Ontario. File No. 4039-W.

CORROSION ENGINEER, M.E.I.C., P.Eng., N.A.C.E. Many years of industrial experience including cathodic protection, coatings, tapes, surveying, testing etc. Desires responsible position with oil, gas or chemical industry. Preferred location in western Canada or U.S. Available on reasonable notice to present employer. File No. 4359-W.

CIVIL ENGINEER, M.E.I.C., B.Sc., Queen's 1943, age 37, married. Experience includes five years' consultant design work on hydro-electric developments and 1½ years' foreign field work on hydro-electric project. Presently engaged in structural design of buildings and structures in reinforced concrete, steel, and timber. Desires change, available on reasonable notice to present employer. File No. 4061-W.

ELECTRICAL ENGINEER, B.Sc. 1946, age 33, married with family. Ten years' experience in electric utility industry on construction, operation and maintenance of substations, transmission and distribution facilities. Active in E.I.C. and Professional Association. Interested in responsible position where abilities and experience may be fully utilized. Prefer location in Eastern Canada. Full details on request. File No. 4397-W.

COST CONSCIOUS CONSTRUCTION MANAGER presently employed seeks change. P.Eng. (Civil); graduate in business administration. Last 5 years manager of general contracting firm. Thoroughly conversant with estimating, costing, tendering, job supervision and general administration. Desires senior position in medium sized construction company or similar appointment. File No. 4640-W.

MECHANICAL ENGINEER, B.Sc.A. P.Eng., Jr.E.I.C. Ecole Polytechnique '55. Married, one child, equivalent of three years' experience in the industrial field: heating, ventilating & air conditioning systems, process piping, oil tanks installation and pumping set, boiler houses, compressed air installation. Specification of equipment. Seeks a position as salesman in the region of Montreal. Owns car. Bilingual. Available with reasonable notice. File No. 4669-W.

ADMINISTRATIVE ENGINEER, Jr.E.I.C., B'industrial engineering, (McGill), extra-curricular studies in accounting and business administration. Over 5 years' industrial experience in U.S. and Canada in manufacturing operations: plant layout, methods studies, material handling, inventory and production control, labour standards, office systems and accounting controls. Canadian citizen, age 28. Interested in responsible position in technical sales or factory management as aide to executive. Willing to travel as required and relocate U.S. or Canada. Further details on request. File No. 4792-W.

MECHANICAL ENGINEER, P.Eng. (Ont.) M.E.I.C., married, age 29; 5 years' apprenticeship, 3 years' design and development of wind turbines and industrial equipment in U.K. 3½ years' technical sales estimating and tendering with 1 year in charge engineering department. Presently employed; 1 year as design engineer on special trailers and their ancillary equipment. Seeking position as project engineer or similar with prospects of advancement. Full details on request. File No. 4796-W.

MANAGEMENT ENGINEER, Jr.E.I.C., B.Sc. electrical 1952, candidate for master's, business administration May 1, 1957, age 27. Diversified experience in power plant construction, electrical plant maintenance and financial analysis. Looking for an opportunity within a small or medium sized company. File No. 4850-W.

ELECTRICAL ENGINEER, Jr.E.I.C., P.-Eng., (Ontario), Graduated 1949 London, England, 34 years of age, maried, presently employed with a prominent electrical manufacturer desires responsible position in industry or with a consulting engineering firm. Experienced in design and development of a-c and d-c machines (also fractional), special drives, navy work, electrical design for industrial plants and oil refineries. Available on one month's notice to present employer. File No. 4937-W.

CIVIL ENGINEER, B.A.Sc., Jr.E.I.C., presently taking O.L.S., age 29, married with two children. Four years' varied construction and estimating experience, one year with consultant doing land subdivision municipal and hydrological work. Desires position where both engineering and land surveying experience helpful. Will answer all enquiries promptly. Would prefer the Kitchener area but this is not a limiting factor. Free to start work November 15th 1956. File No. 4982-W.

GRADUATE CIVIL ENGINEER, London England, class 1951, age 36, married, in Canada since May 1954, P.Eng., M.E.I.C. A.M.I. Struct. E., experienced in design

THE ENGINEERING JOURNAL

Published Monthly by

Vol. 40 No. 3

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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

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Indexed in The Engineering Index

Contents - March 1957

(18,500 copies of this issue printed)

Ground Temperature Investigations in Canada

C. B. Crawford, JR.E.I.C. and R. F. Legget, M.E.I.C.

National Research Council, Canada, Division of Building Research

This paper describes the program of work undertaken by the Division of Building Research, of N.R.C., to determine ground temperature variations in Canada. Some of the practical results and theoretical problems are discussed.

THE VARIATION OF temperature in the ground, with time, and with increasing depth from the surface, is a natural phenomenon with which civil engineers come into contact in many special branches of work. Determination of the depth at which service pipes should be installed, the design of road and airport pavements, calculation of heat losses from structures in contact with the ground, the design and operation of heat pumps — these and similar projects can be carried out efficiently only if the appropriate ground temperature regime is known with reasonable accuracy.

At some depth below the surface, the temperature of the ground ceases to be affected by daily and monthly changes in the surface temperature. In many parts of Canada this depth is of the order of 20 feet. Below this depth ground temperatures usually increase slowly with increasing depth. This phase of the phenomenon is related to the problem of high temperatures in deep mines. Much has been written about the practical aspects of this problem and with corresponding scientific deductions from deep ground-temperature observations.

Between the critical depth noted and the ground surface, the effect of changing surface temperature will be evident to a steadily increasing degree as the ground surface is approached. The increase is not linear; major variations in temperature are greatly reduced within the first two or three feet from the surface. Following the basic laws of heat transfer, there should be a steadily increasing time lag for maximum and minimum temperature conditions. Observations show that in Canada the lag is six months, as the critical depth of approximately steady temperature is approached. These basic features of the over-all phenomenon are shown in graphs accompanying this paper which will be discussed later.

This outline of the pattern of ground temperature variation indicates that the problem of theoretically computing the ground temperature, at any particular depth, in any particular location, at any specified time, is a complex one — so complex that it can be said to be insoluble except on the basis of a number of simplifying assumptions. Variations in soil type, variations in groundwater level, variations in surface vegetation and even in the colour of this vegetation, variation in snow cover, variation in rainfall — these are but some of the factors which will affect the ground temperature regime for anv selected locality. Although generalized solutions can be obtained theoretically for ideal conditions, the study of ground temperature variation is one which must be based, at the start, upon field observations. This is reflected in the literature of the subject which is extensive despite the restricted and special nature of the problem. It has been critically analysed by Crawford (1952)[3]. An early paper of unusual interest records observations made in Edinburgh as early as 1837, by Professor Forbes[5], who used glass bulb thermometers with stems 25 feet long.

Early Measurements in Canada

The first known ground temperature measurements in Canada were made at McGill University by Prof. H. L. Callendar, beginning in October 1894. Electrical resistance bulbs were installed in the side of a trench from the surface to a depth of 9 feet and readings were made for several years (Callendar 1897)[2].

During the years 1921 to 1923 ground temperatures were observed at depths of 1 to 8 feet at 1-foot intervals on the campus of the University of Saskatchewan in Saskatoon. Electrical resistance thermometers were used and temperatures were recorded continuously (Harrington 1928)[7]. From 1929 to 1934 ground temperatures were measured at the University of Manitoba in Winnipeg at various depths from the surface to a depth of 15 feet. Frost penetration was computed from these measurements (Thomson 1934)[15].

During the period 1924 to 1939 ground temperatures were measured in Toronto with electrical resistance thermometers at the surface and at intervals to a depth of 15 feet in sandy soil at the Canadian Meteorological Office. From 1945 until 1952 further readings were obtained at the same site at depths of 4, 6, and 8 feet using a recording mercury bulb instrument supplied by the University of Toronto.

Records of shallow ground temperatures have been obtained for many years and in many locations by the Experimental Farms Service of the Department of Agriculture. Most of these observations have been made in connection with problems of crop culture and the results are not directly applicable to engineering problems. At present a general study of ground temperatures is being carried out at the experimental farms at Ottawa and Fort Vermilion.

Some earth temperature measurements have been made at great depths to study vertical temperature gradients and heat flow (Misener, Thompson and Uffen 1951)[11]; similar work has been done in some of the deeper Canadian mines.

Studies by the Division of Building Research

Shortly after the formation of the Division of Building Research a project was started to determine ground temperature variations in Canada. This project was prompted by a request to the Division to install an experimental heat pump and by an urgent problem relating to frost penetration in the City of Ottawa. Early Divisional work in the north of Canada showed that an accurate knowledge of ground temperature variations was essential in permafrost research. These and other demands for practical information were linked with an increasing appreciation of the necessity for study of the over-all theoretical problem, arising from earlier work of the senior author and from the clear necessity for a long-term study of frost action in soils.

Accordingly, the Division of Building Research has developed a steadily increasing number of field observing stations for ground temperature variations jointly with other organizations. The records so far obtained are already proving to be of much practical value. At the same time they indicate that little is to be gained by a much wider extension of such field observations. The time seems ripe, therefore, for the presentation of a review of the work that has been done in this field, not only to tell the engineering profession in Canada of the information that is available for public use, should it be needed, but also to place on record in convenient form a summary of this extensive field program against which more detailed and theoretical studies can be assessed. This paper is a statement of the field research work into this problem which the Division has carried out, in association with other research agencies noted in the descriptions of the individual installations. The locations of ground temperature installations are shown in Fig. 1.

Current Temperature Measurements

Ottawa, Ontario

Following the severe winter of 1947-48 during which the City of Ottawa had many difficulties with frozen water lines, the Division began co-operatively with the City, a study of ground temperatures under city streets. In the fall of 1948, recording thermometer bulbs were placed under two streets; one in a sandy area and one in a clay area. Readings were taken for two and three years respectively.

In 1949 thermocouples were placed in a vertical profile at 1-foot intervals to a depth of 15 feet in undisturbed clay and to a depth of 8 feet in test pits (Fig. 2) in both sand and clay. These installations were designed to evaluate the effect of air temperatures, soil type, soil density and snow cover on ground temperatures. This work was extended in 1952 with the installation of thermocouples under a snow-cleared roadway and under adjacent grass cover near the Building Research Centre at Ottawa. Readings have been made weekly at these sites.

During the winter of 1954-55 temperatures at 2-inch intervals through natural snow cover were measured to evaluate the thermal properties of snow and its effect on ground temperatures. This study will soon include the measurement of heat flow in the snow.

Aishihik, Y.T.

As part of an international study of temperatures in permanently frozen ground (permafrost), arrangements were made with the U.S. Corps of Engineers and the Dominion Meteorological Service to provide and maintain a ground temperature installation at the air field at Aishihik in the Yukon Territory. In October 1952, thermocouples were placed at three locations: from the surface to a depth of 10 feet at 1-foot intervals in a wooded area and in a brush area; from the surface to 10 feet at 1-foot intervals; and from 10 to 20 feet at 2-foot intervals in a grassed area. Weekly temperature readings have been made.

Aklavik, N.W.T.

During the summer of 1953 the Permafrost Section of the Division installed a number of thermocouples for measuring ground temperatures

FIGURE: 1

LOCATION OF SOIL TEMPERATURE INSTALLATIONS at Aklavik. One string of thermocouples was placed in natural ground under grass cover at intervals of 1-foot from the surface to a depth of 10 feet and at 12.5, 15 and 20 feet. Temperature readings and snow cover measurements have been made every week since August 1954. At the same time twelve additional thermocouple strings were installed on the sites of two proposed buildings: a ten-room school and a teacherage (Pihlainen and Johnston 1954)[13]. These installations were established to study the effects of buildings on permafrost but due to the subsequent decision to relocate the town of Aklavik, the buildings have not been constructed and no temperature readings have been made. It is expected, however, that some of these thermocouples will be read beginning in 1956.

During 1953 thermocouples were also located on the perimeters of four wooden piles immediately after they had been steam-jetted into permafrost. Observations on these thermocouples have given information on the refreezing of such steam-jetted piles in permafrost.

Yellowknife, N.W.T.

In 1951 seven temperature measuring installations were made at Yellowknife by the Department of National Health and Welfare in co-operation with the Division of Building Research. One three-point mercury-bulb recording thermometer was used; thermocouples were used in the remaining installations.

In addition to the general collection of ground temperature information in this area, these installations were planned to give data necessary for the engineering design of municipal services in northern regions where heat input to the system is required. Analysis of the data revealed that for a satisfactory solution of the design problem more precise ground temperature measurements are necessary as well as measurements of water temperatures, flow rates, heat input and a complete understanding of thermal properties of the soil. The complexity of this problem may delay its solution for many years. Meanwhile some guidance for design can be obtained by reference to the data which have been obtained. This information is now being processed for publication.

The Yellowknife installations include two reference stations: one beneath a roadway and one under natural cover. Other installations have been made around water and sewer pipes with temperature measurements recorded above, below, and in and around the pipes (Fig. 3). Temperature measurements have been made since 1951 although, owing to various difficulties, these were not continuous during the first two years of operation. The data confirm that the installation of service pipes has a significant effect on ground temperatures. The topography of Yellowknife is shown with the instrument huts in Fig. 4.

Fort Smith, N.W.T.

One three-point mercury-bulb recording thermometer has been in continuous operation at Fort Smith since May 1952 to provide information for the control of heating of the municipal water supply. This instrument was installed and is maintained by the Department of Northern Affairs and National Resources in co-operation with the Division of Building Research.

Fig. 3. Thermocouples around water main, Yellowknife, N.W.T.

(Photo S. C. Copp)

Fig. 2. Thermocouples located in test pit in clay; Ottawa, Ont.

Resolute Bay, N.W.T.

In 1948 thermistors (electrical resistance type thermometers) were established at shallow depths in the ground at the weather station at Resolute Bay which is situated just south of the 75th parallel and is operated jointly by the Meteorological Division of the Department of Transport and the U.S. Weather Bureau. Later the Dominion Observatory and the National Research Council of Canada joined with the Meteorological Division and the U.S. Geological Survey to establish deep ground temperature observations as a means of estimating the depth of permanently frozen ground and to record long-term changes in permafrost temperatures. Owing to the many practical difficulties of boring through frozen rock this program required four seasons to complete the main deep hole to 650 feet deep.

Temperature measurements have now been made in shallow holes at various depths down to 5 feet since 1948. Since September 1950 readings have been obtained at 5-foot intervals to a depth of 98 feet and this was extended in May 1952 to points at 300 feet and 450 feet. In August 1953 readings began at 50-foot intervals to a depth of 650 feet.

Data from these installations show that the ground temperature at a depth of 20 feet varies annually from about +5° F. to +13° F. At 50 feet the variation is about 1° F. and averages about +8° F. during the year. This temperature remains fairly constant to a depth of about 150 feet where it begins to increase at a rate of about 2° F. per 100-foot depth. Preliminary estimates place the depth of permafrost at between 1,000 and 1,500 feet.

Uranium City, Saskatchewan.

At the request of the Provincial Government of Saskatchewan, the Division of Building Research loaned two three-point mercury-bulb recording thermometers to the Provincial Department of Natural Resources for installation at Uranium City. These instruments were located to obtain design information in advance of the proposed installation of municipal services and to study an unusual permafrost condition which caused problems in road construction at this new townsite. In 1951 both instruments were installed at the Uranium City townsite. During the summer of 1952 one instrument was relocated in the townsite and the other was moved to a location known as "Ice Hill" on the main road near the town to obtain information on an unusual occurrence of permafrost. A typical installation is shown in Fig. 5.

Fig. 5. Typical mercury-bulb recording thermometers, Uranium City, Sask.

(Photo S. C. Copp)

Fig. 4. Typical topography and instrument huts, Yellowknife, N.W.T.

During September 1954 the instrument at the townsite was replaced with a thermocouple installation measuring temperatures under a snow-cleared driveway and under natural snow cover. Because of instrument difficulties satisfactory readings of the thermocouples were not obtained until the summer of 1955.

Saskatoon, Saskatchewan

The Prairie Regional Laboratory of the Division of Building Research made several thermocouple installations on the University Campus at Saskatoon in 1949 to study the effect of a heated building on ground temperatures. Unfortunately the leads from the neutral reference station, extending to a depth of 35 feet, were destroyed shortly after installation. There remain a number of thermocouple strings under and around the building. One string with points at the surface, 1, 2, 4, 6, 8, and 10 feet in depth and located 20 feet from the building will approximate natural ground temperatures. Readings have been made weekly since March 1950.

Winnipeg, Manitoba

In the fall of 1952 many thermocouples were installed in the ground in connection with an experimental basementless house which was constructed on the University of Manitoba Campus by the Division as a joint research project. Temperatures are measured at various depths under and around the slab and at a considerable distance from the slab to a depth of 15 feet. The data from these installations allow study of the effect of the slab on thermal conditions in the ground.

London, Ontario

Dr. A. D. Misener, working at London, Ontario, in co-operation with the Division of Building Research, has installed thermocouples in a grid under the floors of two school buildings to study the effect of floor panel heating on ground temperatures. Additional thermocouples were placed in the ground outside the influence of the buildings. *In situ* field tests for thermal properties of the soil were made.

Labrador

In co-operation with the Iron Ore Company of Canada and the Quebec North Shore and Labrador Railway, several installations for the measurement of ground temperatures were made in 1953 to obtain information for construction and operations. At mile 266 on the railway non-recording remote - reading mercury - bulb thermometers were placed to a depth of 13 feet in a typical granular fill, to a depth of 6 feet in a typical silty cut and at depths of 1.5 and 3.75 feet in muskeg. Weekly temperature readings were made during the first winter but due to inaccessibility further readings are not anticipated. It is hoped that these instruments can be moved to a position in the roadbed near a permanent camp.

At Knob Lake, site of the Iron Ore Company town, recording mercury-bulb thermometers were located under a snow-cleared road to a depth of 9 feet and to a depth of 5 feet under natural cover. This installation was relocated in the fall of 1954 owing to the unexpected extreme penetration of frost in the dry granular soil, and bulbs were placed to a depth of 15 feet under a roadway and to 12 feet under natural cover. Thermocouples were installed with the mercury-bulbs to allow periodic checking of the instruments. Continuous ground temperature readings have been obtained at Knob Lake since 1953.

Results of Field Observations

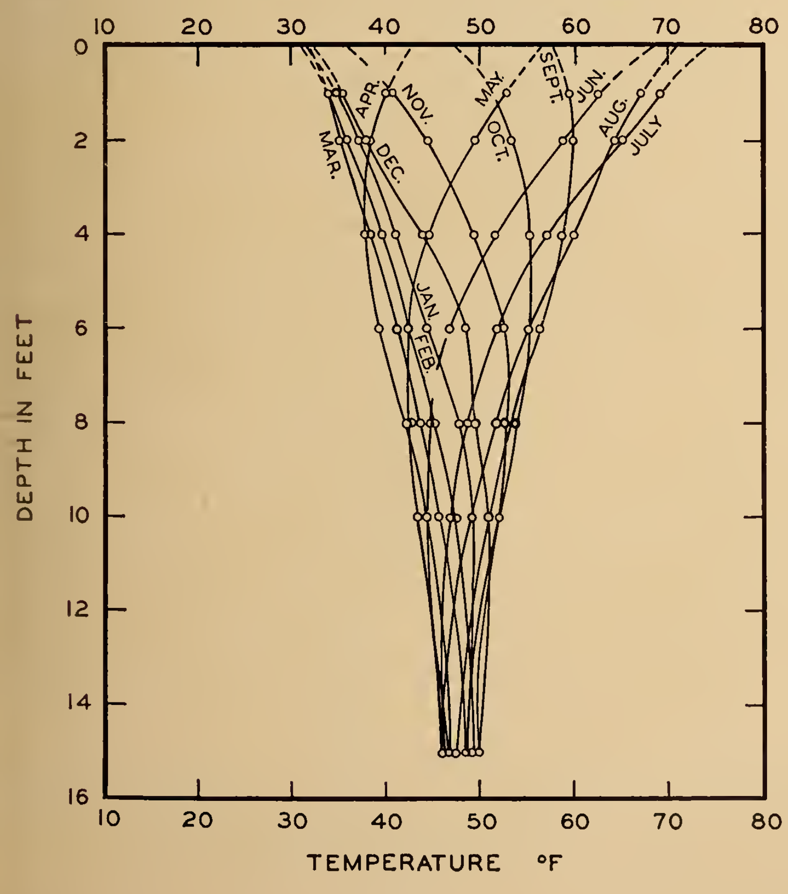
This paper does not record detailed results or even average results of all the temperature installations described; these will be published in individual papers. Some general results, however, are shown in Figs. 6 to 9. Figure 6 shows monthly average ground temperature profiles with depth under natural grass and snow cover in undisturbed clay at Ottawa during one year. These curves illustrate the decreasing mean annual temperature amplitude with depth (43° F. at the surface, 4° F. at a depth of 15 feet).

Temperature lag with depth is also illustrated (coolest in July, warmest in December at 15 feet). Figure 7 shows similar monthly averages in disturbed clay soil with the snow cover removed. Removal of the snow cover causes an increase in temperature amplitude and a decrease in the mean ground temperature. Figure 8 illustrates temperature profiles at Knob Lake in Labrador in a coarse granular soil under a snow-cleared roadway. More severe climatic conditions cause much greater temperature amplitudes (more than 10° F. at 15 feet).

Figure 9, which summarizes Figs. 6, 7, and 8, shows that the mean annual temperature under natural conditions (based on weekly observations) to a depth of 15 feet at Ottawa is approximately constant at 48° F., and increases to 48.4° F. in the upper 3 feet (curve A). The effect of snow cover is illustrated by the decrease in mean annual temperature under snow-cleared ground in the upper 6 or 8 feet (curve B). The depth to which this effect extends will depend on the boundaries of snow clearance, in this case a radius of about 6 feet. The mean annual ground temperature under a snow-cleared road at Knob Lake decreases from 33.5° F. at a depth of 15 feet to about 30.3° F. at the surface (curve C). Boundary conditions for this curve are similar to those for curve B. Mean annual ground temperatures at Knob Lake suggest that this is a region not far removed from permafrost; in the iron ore mining operations some permafrost has been observed.

The most significant feature of these curves of mean annual ground temperatures is the wide variation,

Fig. 6. Monthly average ground temperature in clay soil at Ottawa, Ont., from May 1954 to April 1955 (under natural surface cover).



even without snow cover, between mean surface temperatures and air temperatures. This variation will be discussed in some detail later. It may be appropriate to consider first the main results of the field studies.

Discussion of Results

Much valuable information related to ground temperatures has been published within the last 100 years: information on the thermal properties of soil, the effect of surface cover, precipitation, soil type, water content, organic content and various weather elements notably air temperature. For the most part this information is qualitative or applies to specific cases and is therefore difficult to apply to engineering operations. Probably the greatest single development, for engineering, is the simple empirical relationship between air temperature and frost penetration, first suggested by Casagrande (1931)[1] and later developed by the U.S. Corps of Engineers (1947)[14]. It is recognized that this relationship is an oversimplification with limiting conditions of a complex phenomena but it can be used to estimate frost penetration. A "freezing index" map of Canada (Wilkens and Dujay 1954)[16] can be used with the empirical curve to make a first approximation of frost penetration (Crawford 1955)[4]. The field measurements outlined in this paper have generally confirmed the accuracy of the empirical relationship but it is also important to note that in one case (Knob Lake) the frost penetration was twice as great as the estimate. Many field observations will be required to improve the accuracy of this method.

The field studies have added to our knowledge of the effect of soil type on ground temperatures and have illustrated the great effect of snow cover in preventing the penetration of frost (Legget and Crawford 1952)[9]. More is being learned about the general effect of basementless houses on ground temperatures and heat loss from the slab. It is apparent that the various service pipes greatly affect subsurface temperatures. Perhaps the most important result of field observations is an appreciation of the complexity of the thermal regime in the ground. This leads to consideration of a combined empirical and theoretical approach to the problem.

Evaluation

When one considers the influence which the thermal properties of the soil must have upon ground temperature variations, it becomes evident that the final understanding of this phenomenon must be guided by the theories of heat transfer. Theoretical solutions are complicated because the problem involves transient heat flow in a material with constantly changing thermal properties. On the other hand, field measurements alone will not suffice because it would be necessary to obtain results to cover every possible combination of climate and soil in sufficient numbers for statistical analysis.

In the first approach to the problem by the Division of Building Research, it was planned that study should include theory, laboratory experiments, and field observations. Field observations were begun immediately since a year of measurement is required for one complete weather cycle and because these measurements could provide interim answers to practical problems. During 1955 equipment has been developed and constructed at the Building Research Centre, Ottawa, in which small samples of soil can be subjected to various controlled temperature, density, and moisture conditions. Experiments to study the effects of freezing on various soils are continuing (Penner 1956)[12]. Work and laboratory heat transfer studies is also being planned.

In empirical approaches to ground temperature studies, it has been customary to simplify the problem by neglecting most of the variables which are known to affect temperatures to arrive at workable relationships such as the simple relationship of frost penetration to degree-days of freezing air temperature. This neglects important variables such as thermal properties of the soil (which depend greatly on water content), water movement (with its tremendous potential as a heat transfer mechanism), nature of the ground surface and all of the weather elements except air temperature. To obtain engineering design data the problem must be simplified in this way but it appears to be equally necessary to consider all the variables to achieve a satisfactory understanding of the problem.

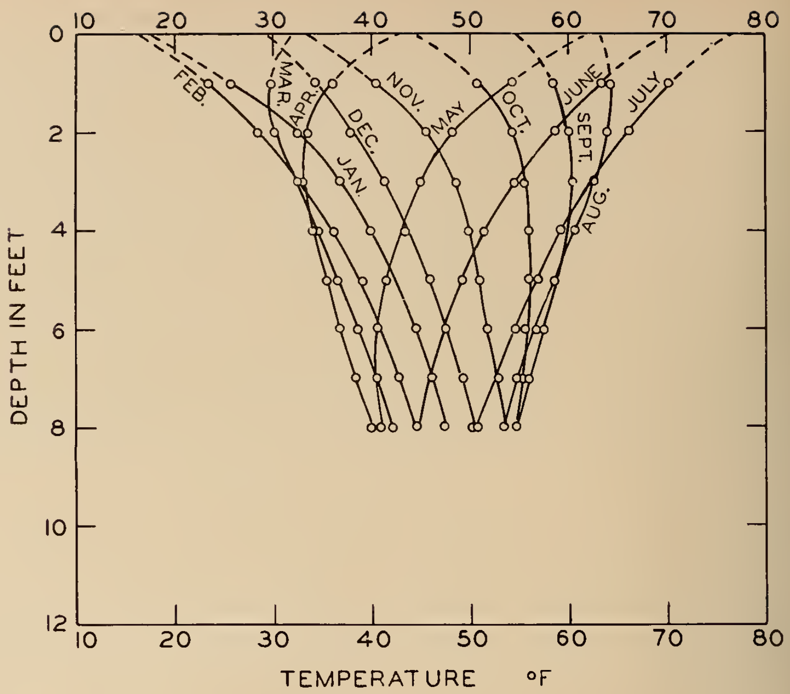


Fig. 7. Monthly average ground temperature in clay soil at Ottawa, Ont., from May 1954 to April 1955 (under snow cleared surface).

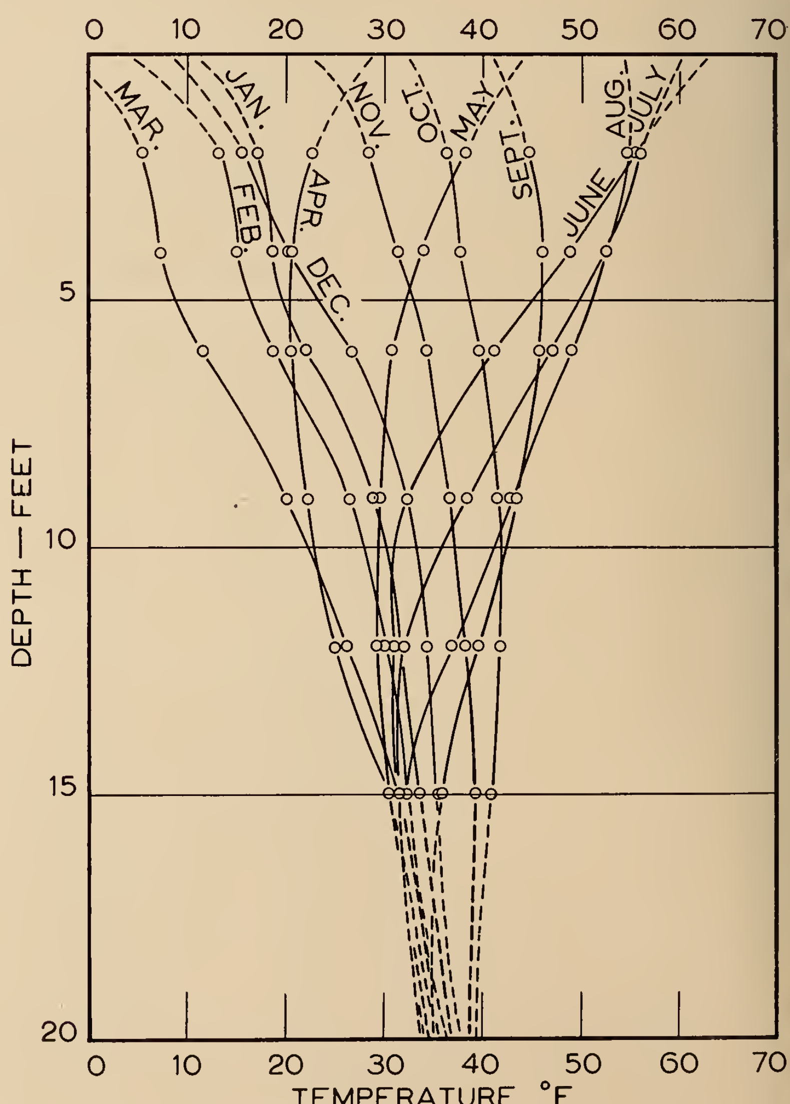
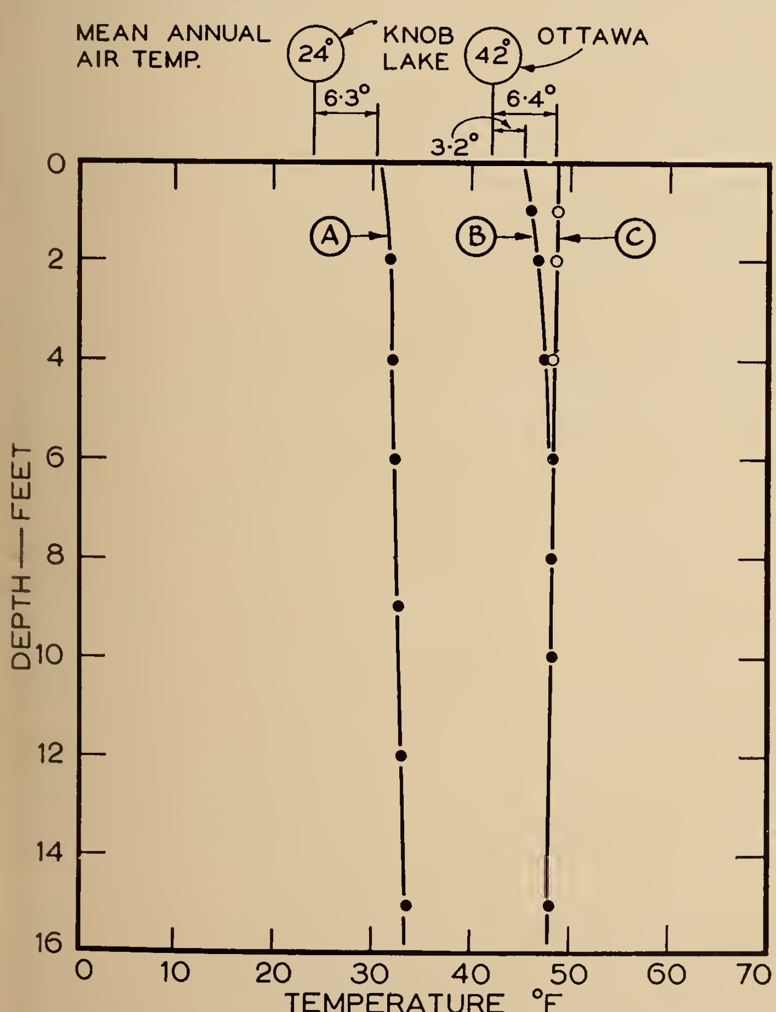


Fig. 8. Monthly average ground temperature at Knob Lake from October 1954 to September 1955 (under snow cleared road).

From Fig. 9 it can be seen that the mean annual temperature of the upper 15 feet of the earth at Ottawa is more than 6° F. warmer than the mean annual air temperature. Even under conditions of no snow cover the difference is more than 3° F. at Ottawa and more than 6° F. at Knob Lake. These curves clearly indicate the influence of snow cover, the effect of climate between Ottawa and Knob Lake, and the fact that there does not exist a simple direct relationship between air and ground temperatures as has generally been supposed to exist.

Further consideration of air temperature as a variable is therefore warranted. Air temperature is chosen as representing the effect of climate on ground temperatures because it is a simple variable, easily understood, and a weather element of long-term record. Further study, however, shows that ground temperature is not wholly a function of air temperature. If mass air movements are neglected the air temperature may equally well be regarded as the result of heat exchange with the earth rather than the reverse. This is caused by the fact that practically all of the heat reaching the surface of the earth results from short wave (high temperature) radiation by the sun, of which only a small amount is absorbed by the atmosphere (Geiger 1950)[6]. About 40 per cent of the radiant energy from the sun is lost to space by reflection from clouds and by diffuse scattering. The remainder, except for the small amount absorbed by the atmosphere arrives at the earth's surface by direct solar radiation and by sky radiation, having had almost no effect on atmospheric temperature. The intensity of this radiation depends on altitude, slope and orientation of the receiving ground surface, inclination of the sun and on various atmospheric conditions. At Winnipeg during 1952, for example, the average cloudless day insolation ranged from about 500 B.t.u. per square foot per day in winter to nearly 3,000 B.t.u. per square foot per day in mid-summer (Mateer, 1955)[10].

Fig. 9. Relationship between mean annual air temperature and mean annual ground temperature.



Examination of the heat exchange at the earth's surface shows that only part of the radiation that reaches the ground results in a net heat gain to the ground. Part of it is reflected directly; the amount of reflection may be largely dependent on the colour of the ground surface. Some is re-radiated as long wave (low temperature) radiation which is absorbed much more readily by the atmosphere than is the incoming radiation and therefore greatly affects the air temperature. Some radiation is used in the evaporation of moisture; this can have a marked effect on both air and ground temperatures. In the net heat exchange, condensation may balance the effect of evaporation. Minor losses to the net heat gain by radiation include convection losses to the atmosphere. During the day there is a net heat gain to the earth and at night there is a net heat loss, the balance between the two depending greatly on the season and on atmospheric conditions. Radiation from the ground surface is particularly important during the long, clear, winter nights. For practical purposes, smudge-pots are often placed in orchards to provide an artificial haze to trap this heat loss.

It is evident from the above, and supported by the curves of Fig. 9, that simple heat conduction theory does not apply at the air-to-surface interface although it may be correct within the ground, except for the complications of heat transfer by moisture movements. Field work by the Corps of Engineers and at the University of Minnesota (Kersten and Johnson 1955)[8] indicated a discrepancy in using air temperature to compute frost penetration and this has resulted in an air-surface correction factor to obtain a "pavement freezing index". This may prove to be the most practical engineering approach for estimating frost penetration. For research studies designed to understand the ground temperature regime, however, it will be essential to consider all the basic climate factors.

Research on ground temperatures has not yet answered the question of when to make field measurements and when to attempt theoretical analysis. Field measurements give a quick answer without requiring a basic understanding of the problem.

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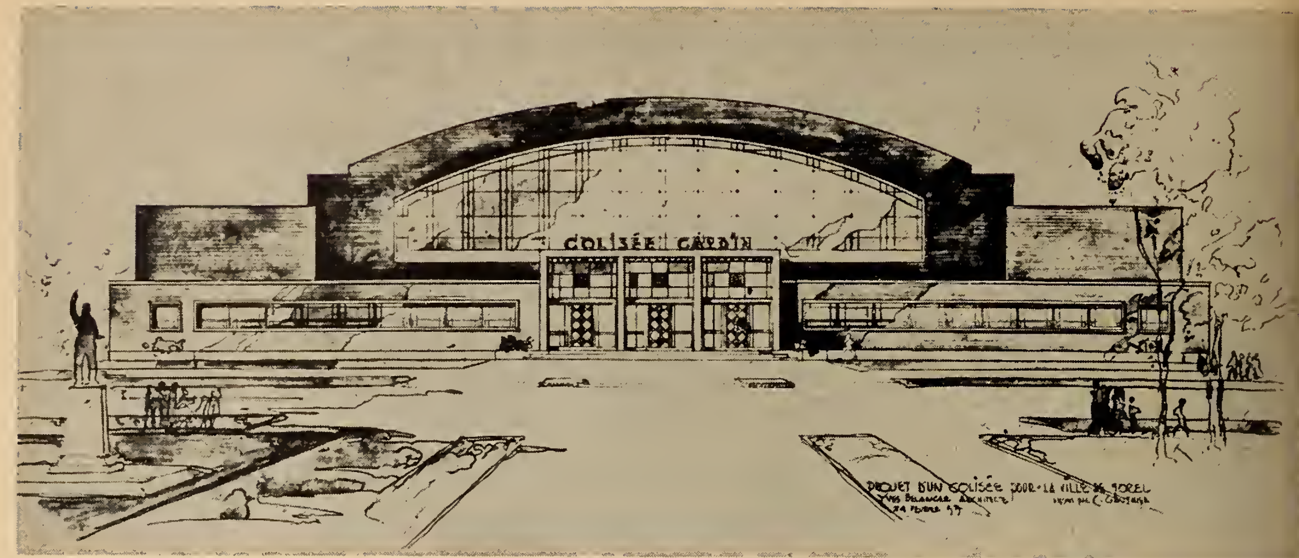


Fig. 1. Artist's sketch of front elevation of stadium.

The Design of Sorel Stadium

with special reference to its foundations

G. G. **Meyerhof,** M.E.I.C.
Head, Department of Civil Engineering, Nova Scotia Technical College

L. A. **Fraikin,** M.E.I.C.
Vice-President and Managing Director, Franki of Canada Limited

In spite of unfavourable soil conditions collaboration between client, consulting engineers, and foundation specialists enabled a safe and economical design of superstructure and foundations of the Sorel stadium to be obtained. The 3-hinged steel arch ribs, seating, and walls rest on groups of caisson piles of 30 feet length in a fine silty sand with clayey silt varves and a high ground water table. A detailed site investigation included dynamic and static penetration tests and obtaining undisturbed soil samples for triaxial compression and consolidation tests in the laboratory. From these tests and recent bearing capacity theory the ultimate bearing capacity of the caisson piles was estimated, and a check of the safe load was obtained from a loading test on a typical pile. Test results were also used to estimate the probable movement of the pile groups under the maximum working load, and an allowance for the corresponding settlement and spread of the support was made in the design of the arch ribs. Settlement observations showed that the actual movements were less than estimated and that the foundations were entirely satisfactory.

THE NEW SOREL Stadium which serves as an amphitheatre and arena is located adjacent to the old open stadium in the southeast part of the town of Sorel, Que. The structure has an arched roof with glazed gable ends and presents a pleasing appearance enhanced by the layout of the brick walls (Fig. 1). The superstructure embodies six steel arch ribs of 3-hinged construction in order to accommodate some foundation movement. The ribs have a span of 130 feet and are spaced at 38 feet centres. The site of the arena is practically level and is underlain by a fine sand of great depth.

During the installation of the caisson piles (see below) the foundation conditions turned out to be less favourable than had been anticipated from a preliminary soil exploration. It became necessary, therefore, to carry out a more detailed site investigation in order to ascertain the mechanical properties of the underlying soil and to estimate the bearing capacity and probable movement of the caisson piles under the load. As part of this work, a loading test was made on one of the piles and the behaviour of the foundation was observed during and after construction as described in this paper.

Soil Exploration

Dynamic and static penetration tests were made at four locations on the site to obtain information about the relative density of the soil and the bearing capacity of the piles. In addition three boreholes were put down using a foil sampler to obtain sensibly undisturbed and continuous soil samples to a depth of about 5[illegible] feet; the samples were carefully transported to the laboratory for testing. The boring records and results of the penetration tests showed that the soil was fairly uniform over the site and consisted of some 5 feet of compact light-grey medium san[illegible] underlain by a fluvio-glacial dark-grey fine silty sand with clayey silt varves (Fig. 2 and 3). The water table was about 5 feet below ground level in the boreholes at the time when the observations were made.

In the upper 15 feet, approximately, of the silty sand stratum, the varves were ⅛ to ¼ inch thick and occurred at ¼ to ½ inch intervals (Fig. 4). The sand was in a compact state (standard penetration resistance of 10 to 15 blows per foot of penetration) and had an average porosity of about 43 per cent. The minimum and maximum porosities which could be obtained in the laboratory were 46 and 57 per cent respectively. Between a depth of about 15 and 25 feet, the clayey silt varves increased to a thickness of ¼ to ½ inch at intervals of 1 to 2 inches and the soil became somewhat softer. A soft silty clay layer was found between about 21 and 23 feet depth below ground level. Below a depth of about 25 feet the clayey silt varves were similar to those found in the upper portion of the stratum. There were, however, some softer sections up to about 1 foot thick at irregular intervals. The sand was generally in a compact state with an average porosity of 44 per cent.

Triaxial compression tests were made in the laboratory on full-sized specimens of about 2½ inches diameter and 8 inches length. The results of consolidated-undrained and drained tests indicated a minimum angle of internal friction of 38 and 40 degrees, respectively, within the pressure range of 0 to 5 tons per square foot. Consolidation tests were made on the silty sand samples. Typical consolidation - time curves showed that the major portion of the movement took place during the first minute. While the compressibility of the sandy portion of the soil was very low, the compressibility of the silty material was appreciable as shown by the void ratio-pressure relationships.

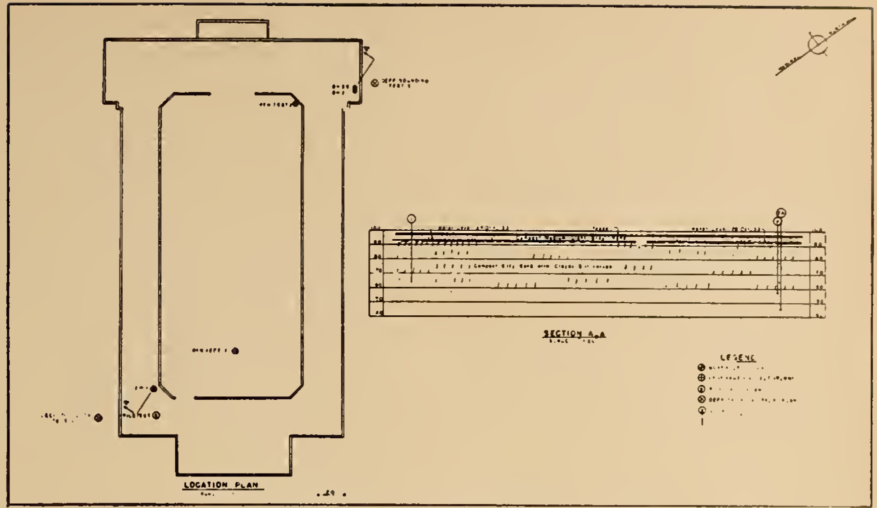
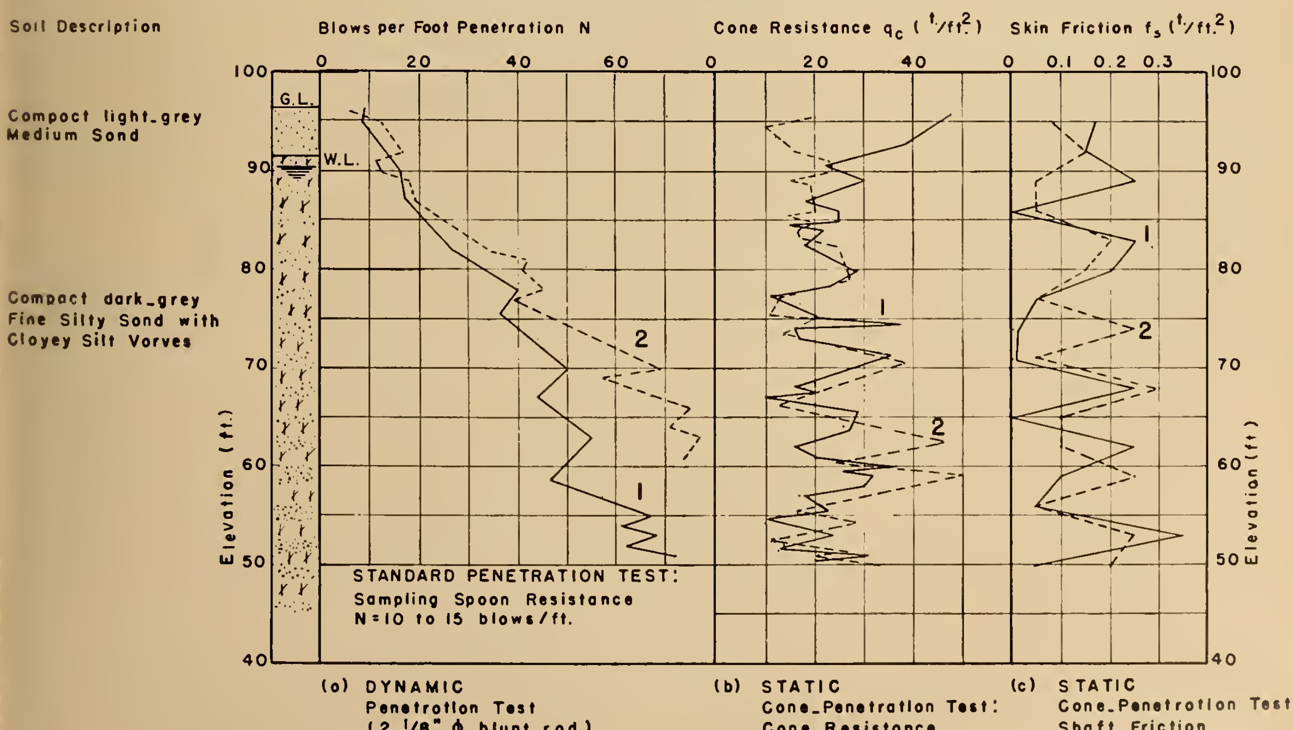


Fig. 2. Plot plan and stratigraphy of site.

Design of Foundations

When selecting the best type of foundation for a particular building, the soil conditions encountered should not be the only concern of the engineer. He has to take into account the rentability of the building and design the superstructure, keeping in mind that he has to achieve a balanced distribution of costs between this superstructure and the hidden part of the building, the foundations. If costs of foundations giving full rigidity to the structure are such that a project has to be abandoned, the engineer is not fulfilling his obligations towards his

Fig. 3. Results of dynamic and static penetration tests.



client, if he does not suggest an alternative solution for the foundations requiring perhaps the re-design of a superstructure permitting some movement of the foundations. The design of the Sorel stadium was an opportunity to show that full cooperation can be obtained between the client, the engineer in charge of the project, and the engineer called in to design the foundations.

It was known that no heavy building could be contemplated in the area of the town chosen as the best location for the stadium, unless the owners were willing to pay for very deep foundations. The first soil investigation made rapidly indicated firm bearing soil at a depth of 90 feet or more. This meant that the whole project would have to be abandoned if foundations could not be established successfully at depth of about 30 feet below the surface, even if this meant re-designing the superstructure to take care of possible movements, these movements being estimated and kept under control due to the advanced stage of the science of soil mechanics.

Accordingly, the client and the engineer in charge of the design of the superstructure, approached the Franki Compressed Pile Company, to see whether their system of foundations could be suggested for this project. The problem was then solved by this company as follows. First, as the original soil investigation indicated a granular soil formation into which the expanded base of the caisson piles could be formed with success, a rig (Fig. 5) was brought to the site of the stadium and a test caisson pile was concreted (Fig. 6). Second, since the driving and concreting of this pile indicated that soil conditions as originally known were not encountered, additional soil investigations and laboratory tests were carried out. Third, a loading test was made on the caisson pile in order to determine its bearing capacity under the actual subsoil conditions.

Fig. 4. Section of borehole sample of varved silty sand.

Fig. 5. Rigs for installation of caisson piles.

The results of these various tests are given below. From these the safe bearing capacity of the caisson piles was determined, and the design of the foundation thereafter did not present any particular difficulty. The arch ribs were carried by groups of five 30-feet long caisson piles, four piles on a batter of 17½ degrees and one pile vertical in order to take care of the dead loads during construction (Fig. 7). Only the batter piles were reinforced.

Bearing Capacity of Caisson Piles

For the purpose of estimating the bearing capacity of the caisson piles, the diameter and length of the shaft were taken as 2 feet and 27 feet, respectively, while the base (bulb) of the pile was taken as 4 feet diameter. The bearing capacity of this pile depends on the shearing strength of the sand between a depth of about 25 and 35 feet. Because of the low permeability of the clayey silt varves in the sand, the angle of internal friction governing the bearing capacity will be between the values of 38 and 40 degrees obtained in the consolidated-undrained and drained triaxial compression tests. On the basis of bearing capacity theory[1] the ultimate bearing capacity of the caisson piles was estimated to be about 150 tons per square foot of base area. This value is about the same as the compressive strength to the concrete of the shaft and may, therefore, be considered as the upper limit of the theoretical bearing capacity.

It is of interest to compare this estimate with the point resistance observed in the penetration tests. The average cone resistance determined in the static (deep sounding) penetration tests at a depth of some 30 feet was about 30 tons per square foot (Fig. 3), which corresponded to a loose state of packing and was considerably less than estimated above; the difference may be due to the low shear strength of the silty clay varves. On the other hand, the dynamic (standard) penetration test gave an average of 12 blows per foot at a depth of 30 feet which would indicate a bearing capacity of about 50 tons per square foot on the basis of recent field investigations[2]. These estimates give thus an average of 40 tons per square foot, which may be taken as the lower limit of the theoretical bearing capacity because of the negligible soil compression in penetration tests compared with the large compaction of the soil by the expanded base of a full-scale caisson pile[1]. The bearing capacity of the caisson piles estimated from the driving resistance of the 20-inch diameter pile tube was of the order of 90 tons per square foot according to Hiley's pile driving formula. This latter estimate is between the values determined from bearing capacity theory and the penetration test results. The various estimates indicate therefore an average value of the base resistance of 90 tons per square foot.

Unfortunately, it is not possible to compare these estimates with the results of the loading test on the test caisson pile, because the test was stopped long before the ultimate bearing capacity of the pile had been reached (Fig. 8). The maximum load applied was 90 tons or about 7 tons per square foot of base area when the settlement was only about 0.3 inch. At the ultimate load, the settlement is likely to be several inches. Since the actual load on the caisson piles supporting the structure did not exceed about 60 tons or 5 tons per square foot, an adequate factor of safety was provided against shearing failure of the soil.

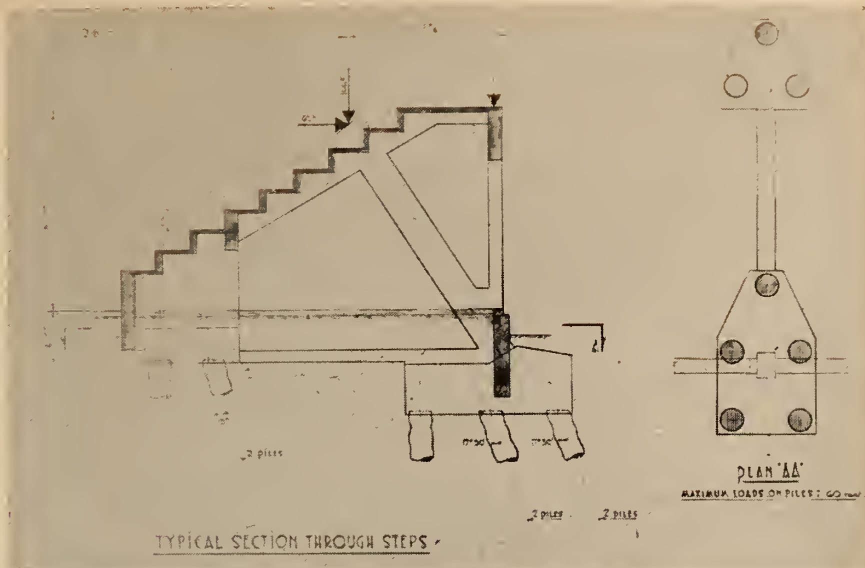


Fig. 7. Typical section of seating and pile group.

Settlement of Caisson Piles

The vertical reaction and horizontal thrust from the arch ribs are combined with the vertical loads from the walls, seating, and supports to give a maximum structural design load of 235 tons inclined at 1 in 3 to the vertical and distributed on a group of five caisson piles (Fig. 7). Since the resultant load acts practically on the centroid and in the direction of the four batter piles, they may be considered as taking the full load. The maximum working load per caisson pile was therefore 60 tons or 5 tons per square foot of base area. On account of the close spacing of these piles in the group, its effective base diameter may be taken as 8 feet.

The total movement of the caisson piles consists of immediate movement, which can be estimated from triaxial compression tests, and consolidation movement, which is estimated from consolidation tests. On that basis, the theoretical immediate movement was about ¼ inch, while the theoretical consolidation movement was about 1½ inches; the total estimated movement was thus of the order of 2 inches. On account of the rapid consolidation, most of the movement would occur on application of the load. This movement, which takes place in a direction of 1 in 3 to the vertical, would lead to a vertical movement (settlement) of the pile group of the order of 1¾ inches and a corresponding horizontal movement (spread) of the order of ½ inch. Accordingly, in the design of the arch ribs an allowance for 2 inches settlement and 1 inch total spread was made.

As a check of the estimated foundation movements, levels were taken on the pile groups of the foundation during and after construction of the stadium. The first observations were made at the beginning of June 1954 after the caisson piles had been installed, but before any load from the superstructure was applied. The second observations were made during the second half of that month when the concrete work of the seating had

Fig. 6. Base of typical caisson pile.

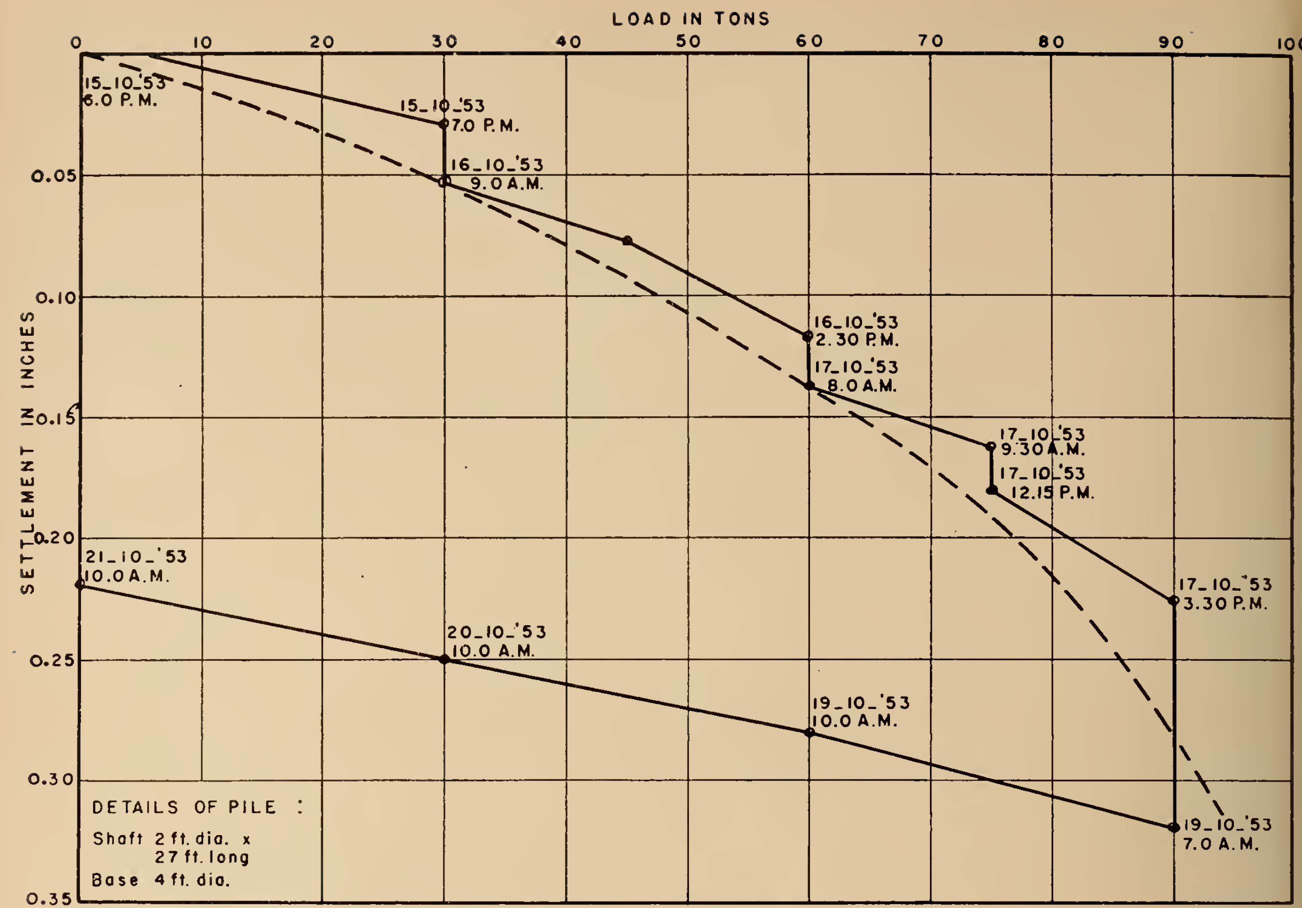


Fig. 8. Result of pile loading test.

been finished. At that time the maximum pile load was about 30 tons, or one-half of the full amount. No significant movements were recorded along the outside rows of the caisson piles, but the inside rows of piles had settled from about ⅛ to ½ inch. The third settlement observations were made in January 1955 after completion of the superstructure and under snow load on the roof, when the maximum pile load was about 60 tons. The total settlement varied from ¼ to ¾ inch (maximum differential settlement of ½ inch) and was greater in the south end than in the north or entrance end of the stadium. This confirms the results of penetration tests which had indicated somewhat better soil conditions in the latter portion.

It is of interest to compare the results of these settlement observations with the movements estimated from theoretical considerations and the results of the pile loading test. The maximum settlement of ¾ inch is approximately one-half of that estimated from settlement theory. This difference is partly due to the probability that the full design load does not always act on the foundation, partly due to a necessarily conservative estimate and partly due to the compaction of the soil within a large zone by the formation of the caisson piles.

It is believed that the last two factors are the main reasons why the observed settlements are less than the theoretical estimates in the present case. Thus, the estimates were conservative because in a compact fine varved sand the soil structure is particularly sensitive to disturbance so that it is very difficult to obtain completely undisturbed samples for laboratory tests. The slightest, almost unavoidable disturbance loosens the structure of the soil samples and thus leads to a greater compressibility being recorded in laboratory consolidation tests than corresponds to the soil below the foundations. Moreover, when the large expanded bases of caisson piles are formed in a granular soil as underlying the present site, the density of the soil is increased, especially where the caisson piles are arranged in groups as in the stadium foundations. This compaction of the soil from installation of the caisson piles reduces the compressibility of the soil near the piles and cannot yet be considered in theoretical settlement estimates.

The observed settlement is about five times that indicated by the pile loading test. This indicates the usual shortcoming of such a test on a single pile which always settles considerably less than a whole group especially where the soil contains some silt and clay as on the present site. No observations were made on the lateral movement of the pile groups. But since the main caisson piles were inclined at a batter of 1 in 3, it may be assumed that the horizontal movement was about one-third of the vertical movement or approximately ¼ inch maximum. The observed movements were well within the limits that could be tolerated by the superstructure and showed that the design and construction of the foundations were entirely satisfactory.

Acknowledgment

The consulting engineers for the Stadium were Messrs. Brouillet and Carmel, Montreal, Que., who also made the settlement observations. The soil investigation was carried out by the Foundation Company of Canada, Limited, Montreal. Que.

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(1) Meyerhof, G. G., "The Ultimate Bearing Capacity of Foundations". Geotechnique, 1951, vol. 2, p. 310.

(2) Meyerhof, G. G., "Penetration Tests and Bearing Capacity of Cohesionless Soils"; Proc. Amer. Soc. Civ. Eng., J. Soil Mech. and Foundation Div., 1956, vol. 82, no. SM1, Paper no. 866.

Modernization of a Paint Finishing Area

W. J. Flynn, JR.E.I.C.

Northern Electric Company Limited, Belleville, Ont.

HOW MANY persons buying an item look beyond its appearance? Very few people can understand the complicated mechanisms of to-day. Hence, they look wise while the salesman discusses the different technical points and then base their decision on the appearance. Although the primary function of the finish is protection from corrosion, the appearance, hence finish, quite often can either make or break the product.

Because of competition it is necessary to strive for the best product at the lowest price. As a result finishing cost must be held down while quality is maintained or improved. An investigation was undertaken in 1954 to determine the finishing cost at Northern Electric's Belleville plant and to determine what steps could be taken to reduce it and to improve quality.

Faults of Old Area

This investigation disclosed serious errors and omissions in the construction and location of the original finishing area. It was situated in the middle of the plant and was not separated from the remainder by an adequate fire-resistant partition. It was also crowded, and adequate space around the equipment for proper fire protection and maintenance did not exist.

A survey of rejected finishes for the period between October 1st, 1953 and October 1st, 1954, indicated an average of 15 per cent of the items were rejected for inferior finishes. This was due to the high standard of quality called for on JCNAAF specification of the Canadian Military Electronic Standards Agency of the Department of National Defence, and also the high quality demanded in Bell Telephone and Northern Electric equipment.

Investigation showed rejected finishes resulted from dust and foreign material embedded in the painted surfaces. This was traceable to a condition of negative pressure arising from exhausting more air from the area than was being introduced to it through the filters. This caused dust-laden air to be drawn through any cracks and openings in the walls.

In tangible terms this meant that out of about 14,000 hours spent on finishing 2000 hours were spent on re-working the rejected parts and an extra 2576 hours were spent in stripping and rubbing down. In addition $2,400 worth of materials were used in refinishing.

Design Principles

Three main points were considered in designing a paint finishing area to correct these conditions.

(*a*) Provision of an adequate space with maximum fire protection for plant and personnel.

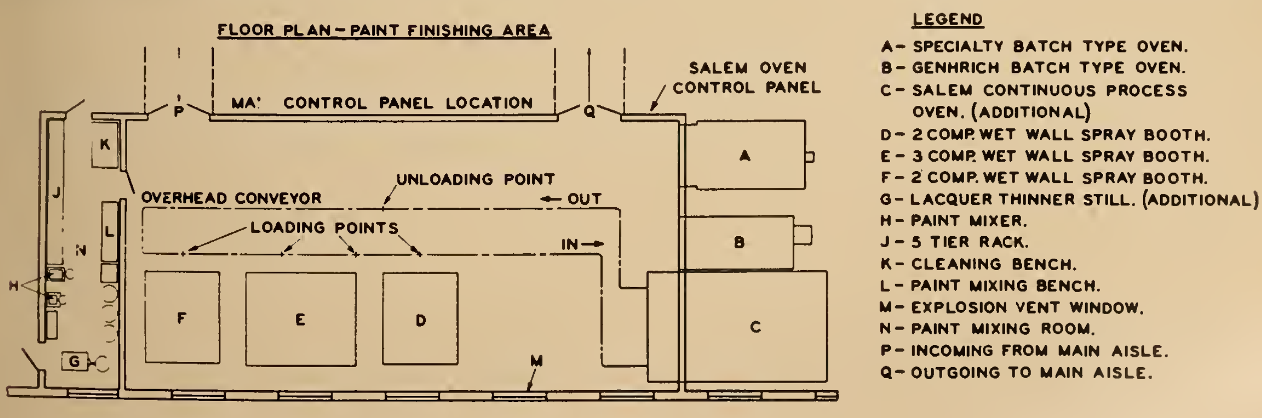
(*b*) Provision of equipment to produce the best quality finish.

(*c*) Provision of equipment and arrangement of work flow to ensure finishing would be done at the lowest cost.

Fire Protection to Plant

Maximum fire protection to the plant is achieved by having the area on an outside wall and enclosed by a concrete block wall with a minimum of two hours fire resistance. All doors and duct openings are equipped with automatic fire doors

Fig. 1. Floor plan of paint shop finishing area, showing arrangement of equipment and work flow pattern.



to contain a fire. Protection from explosive force is accomplished by having all windows of an explosion-venting type which automatically open to relieve the force. The venting area for these windows is designed on the basis of one square foot for every fifty cubic feet of room volume; this is in accordance with the Fire Underwriters and Department of Labour requirements.

Fire Protection of Personnel and Equipment

Protection of equipment and personnel is provided by an automatic sprinkler system with fog type nozzles spaced for coverage of 90 square feet per sprinkler. The floor is sloped one inch in six feet to scuppers in the outside wall permitting the sprinkler run-off to leave the building directly, thereby decreasing the explosion potential. The base floor is covered with marblette, a non-sparking, non-skidding material impervious to acids and alkalies.

To minimize fire or explosion hazard due to electrical apparatus, all motors and switches in the room are of the explosion-proof type for Class 1, group "D" locations. Only three motor switches, for the vacuum still and paint shakers, are inside, all others are located on a control panel outside the area. Light fixtures for the paint mixing room are of the explosion-proof type, due to the greater risk in the dispensing area, whereas the fixtures for the spray area are vapour proof. To insure that all apparatus will be turned off if a fire or explosion should occur, all motor starters are controlled by three Sprink-la-stats, set for 135 deg. F, which will open, closing off the master control circuit and opening all switches.

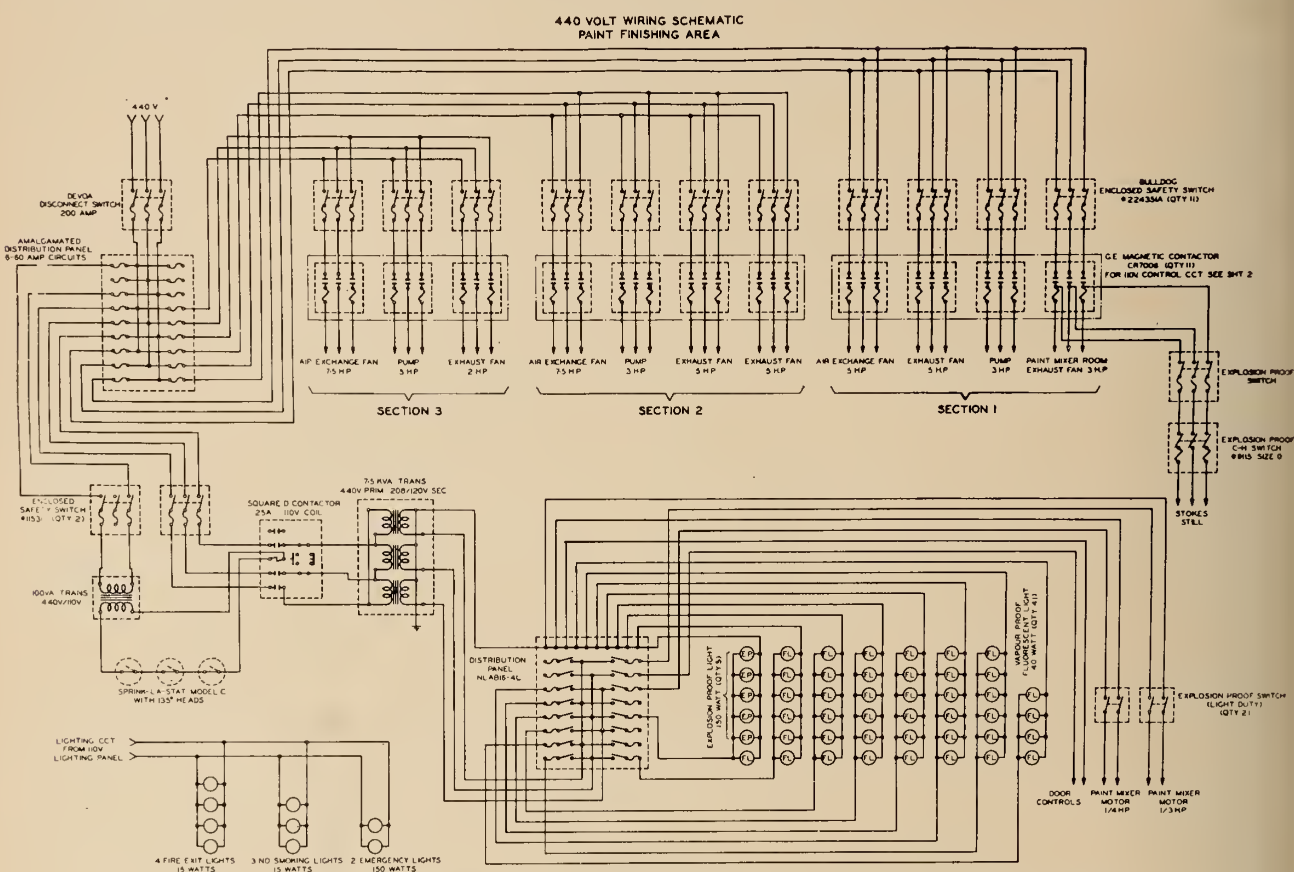


Fig. 2. Wiring schematic, 440 volt. Sprinklers are operated by temperature controlling all electrical apparatus in area. Note also emergency lights, which are on a separate circuit.

Maintenance

All equipment in the area is spaced three feet apart for greater fire protection and ease of maintenance. Periodic inspections and cleaning cycles have been arranged to keep all equipment in good operating condition, thereby minimizing costly production delays and also eliminating the risk of possible fires caused by worn-out apparatus.

Correction of Dust Problem

Presence of dust or foreign material embedded in the painted surface constitutes a main cause of rejected or inferior finishes, as stated previously. Pressurizing the area by supplying an excess of dust-free air from three air intake units minimizes this condition. The first step in accomplishing this was to ensure that all paint booths had proper exhaust. For booth type hoods our standard is a velocity of 150 feet per minute across the booth opening; this is the minimum requirement as stated by the American Society of Heating and Ventilating Engineers. The second step was checking all other exhausts, such as cleaning bench and ovens to ensure they had the minimum ventilation requirements. Lastly, the sum total of all the exhausts was found and increased 5 per cent to allow for leakage. This figure represented the total input of dust-free air required. The ventilation was then checked to the minimum requirements of the Fire Underwriters and Department of Labour, which is 0.25 c.f.m. per sq. ft. floor area, and was found to be adequate.

As the design required three ovens and three booths it was decided to use three air replacement units and to interconnect them to ensure that no air could be exhausted without dust-free air being drawn in. This latter was accomplished by installing a pressure operated switch in the dis-

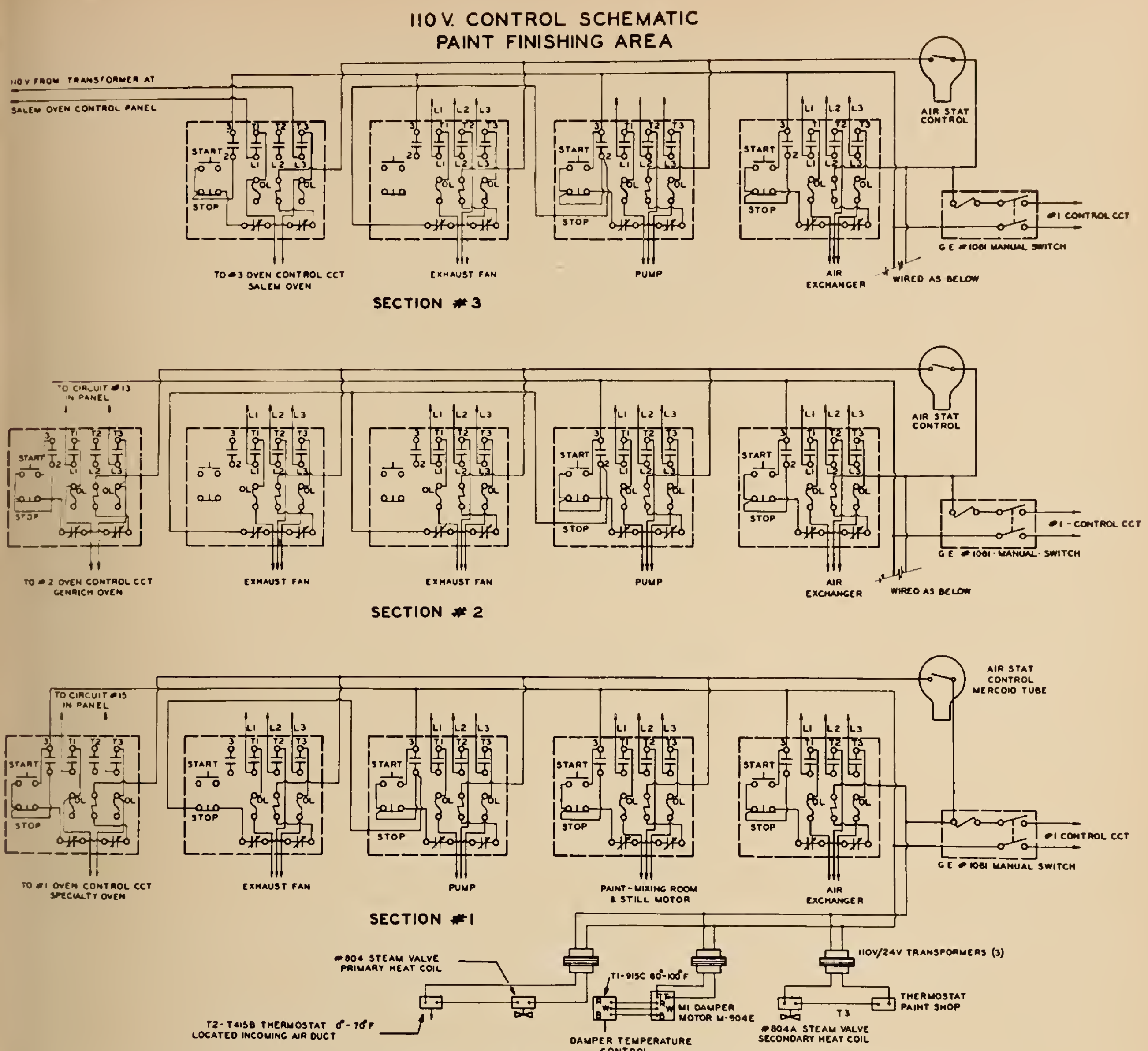


Fig. 3. Schematic wiring diagram of the 110 volt control circuit showing interconnection of motor starters, which prevent air from being exhausted without filtered air being drawn in.

charge duct of the replacement units controlling the motor starters of the exhaust fans. Thus, unless air is being pushed into the area and operating the switch the exhaust fan will not operate.

The ceiling of the plant consists of dressed 2-in. x 3-in. planks on edge and it was thought this type of construction constituted a definite fire hazard, and that some preventive action would be required. However, on checking the revised fire regulations it was found that no ceiling treatment was necessary. The regulations had been changed after the "Levonia" fire when it was shown it is better for the fire to burn through the roof and burn itself out rather than be contained below where it can be supported by the built-up roof. Due to the numerous cracks and crevices inherent in a plank roof it was felt this type of ceiling might provide us with a dust problem. It was therefore decided to install aluminum foil over the deck as a vapour barrier. This was then covered with Masonite to present a smooth ceiling. The new roof has proved very effective and in addition is easily cleaned. An added step to minimize the possibility of fire has been the provision of 3-in. clearance around the ducts passing through the ceiling. This space has been packed with asbestos.

Uniform Temperature

Consistent quality in gloss and uniform paint film thickness are necessary from piece to piece. This is achieved by maintaining a constant temperature in the area, thereby permitting constant paint viscosity and a greater control in paint mixing. The temperature is held to 78 deg. ± 2 deg. F. by thermostats controlling the steam flow to the coils of each air intake unit.

Lighting

The lighting is arranged to provide a minimum of 50-foot candles in the paint mixing room and the paint booths and 35-foot candles in the remaining area. Adequate lighting has not only cut down operating fatigue but, in addition, has minimized streaking of the product by enabling the operators readily to distinguish demarcation lines in the spray pattern.

Results

The foregoing measures have resulted in a sharp reduction in the cost of finishing. Since all painting, baking and air drying is done in the dust free area of the paint shop, rejects have been decreased to 5 per cent. This has decreased the reworking the rejected finishes from 2,000 to 660 hours. In the meantime, however, actual quality standards have been raised with the effect that only two-thirds of the originally estimated savings on the old quality standards have been realized.

New Equipment

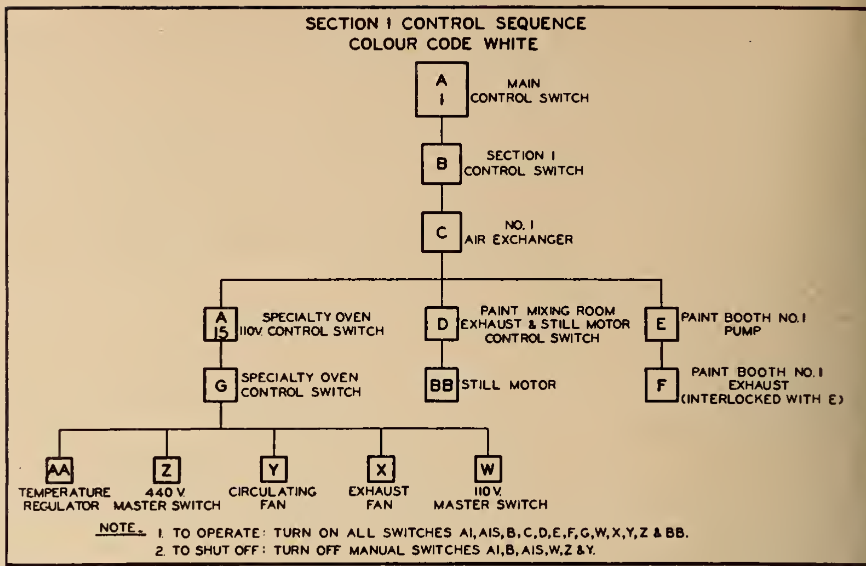
Further savings have been effected by the provision of a conveyor oven and a vacuum still. An average of 3500 gallons per year of lacquer thinners are used to clean guns, cups, and equipment. About 75 per cent of this material is recovered and reused, after the solids have been removed, by the vacuum still. The operation is automatic and very economical since the paint mixer loads and unloads the still in his free time. An interesting and unexplainable point is that reclaimed thinners have been found to do a better job of cleaning than the original thinners.

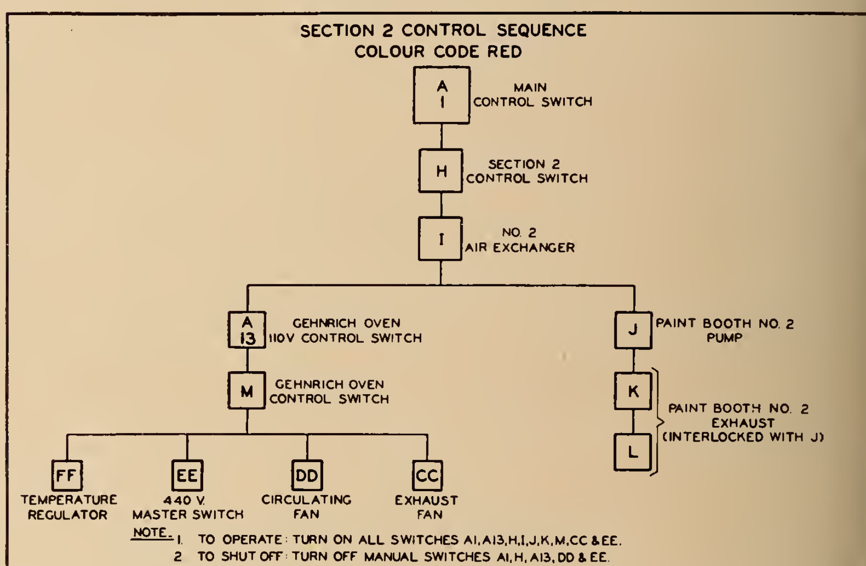
Ovens

Previously the output of the paint finishing area was dependent on the oven capacity. As this was low, it tended to reduce the production rate. Installation of an additional oven has made the output dependent on the painters with a resultant significant increase in production. Also, as the new oven has a conveyor, interruptions from loading and unloading have been decreased. From studies made before and after the completion of the area it has been found production increased 40 per cent making possible a saving of approximately 4500 hours.

All ovens are installed with their fronts flush with the inside wall of the area and oven proper extending through the wall into the surrounding shop. This provides an increased area in a dust-free location for air dried finishing, presents a neater layout and reduces a source of dust which in turn lessens the cleaning time for the paint shop.

A further slight saving has been achieved by the installation of power operated doors. A study indicated the doors are opened and closed some 41,000 times per year. The time to open and close the doors has been decreased from 30 seconds to 10 seconds with a resultant saving of 228 hours.





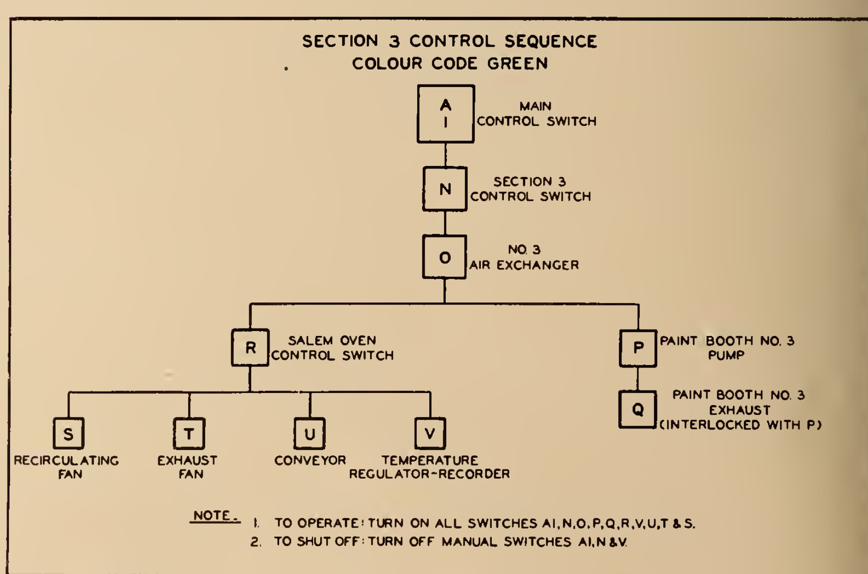
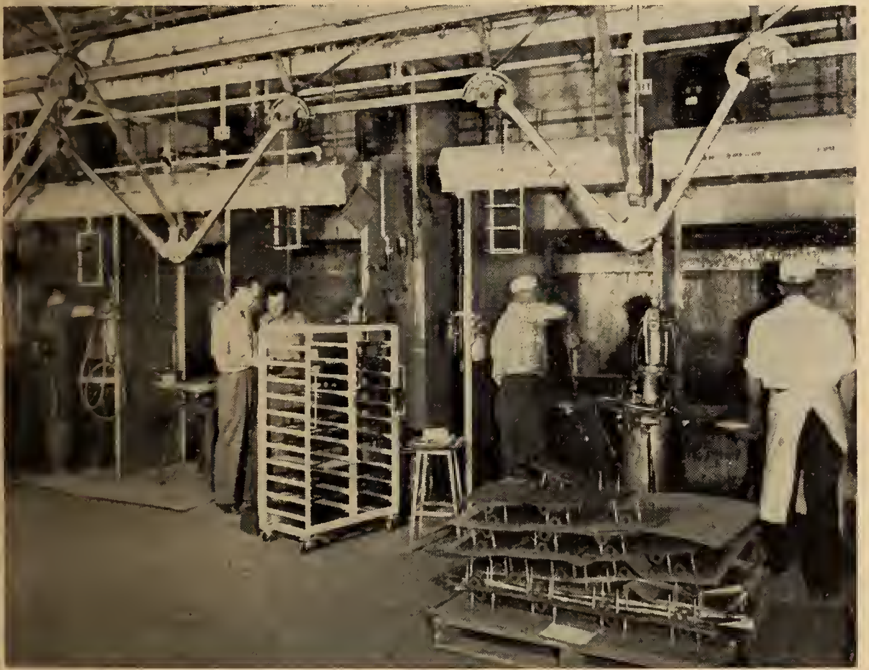
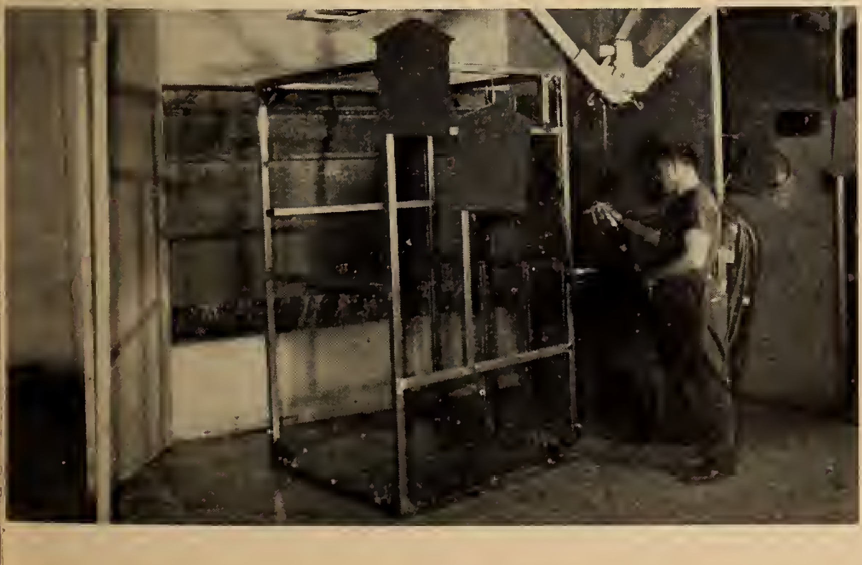


Fig. 4, 5, 6 (from top). Control sequences for sections 1, 2, and 3, indicating sequence in which switches must be turned on to operate units. All switches are painted in the section colour and codified for easy identification.





The locations of the doors were selected for good work flow. All parts enter through the "in" door and are distributed to the booths. From there they proceed to the curing area at the opposite end of the room. After curing they leave the area through the "out" door for inspection and lettering. In this way, crossover of traffic is held to a minimum.

The paint shop itself is ideally located for work flow since it is situated adjacent to lettering, inspection, and packing areas and close to mechanical assembly and stockrooms.

Adaptability of Area and Equipment

An outstanding point not covered so far is the adaptability of the paint shop to meet changing loads, parts and finishes. For this reason only convection type ovens are used. Also, although there are positions for seven painters since two two-compartment and one three-compartment spray booths are available, partitions in booths are removable to permit entry of extra large parts. To handle even larger parts the side of the number 3 booth is arranged to swing open to make an opening 10 ft. high by 10 ft. wide. Only water wall spray booths are used to minimize the contamination of outside air and also reduce the fire potential.

In line with the provision for large parts one door of the paint shop was made 10 ft. high while the other was held to 8 ft.

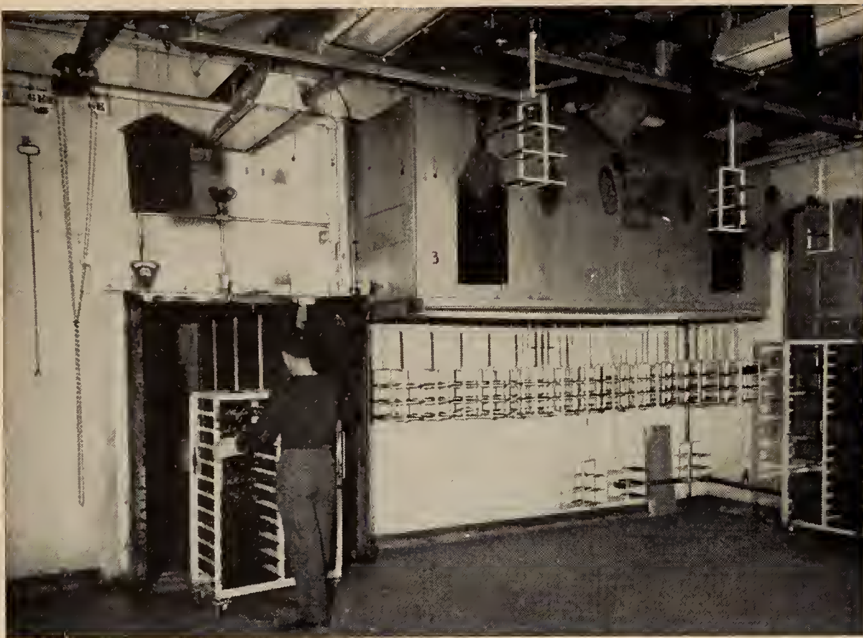
Conclusion

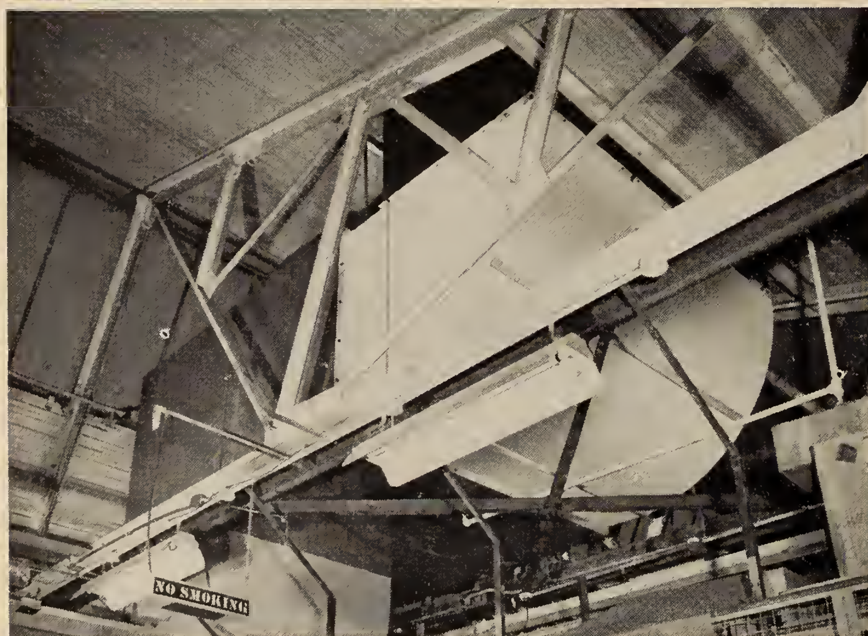
Since installation we have had trouble with the air intake units freezing. No complete explanation can be given but the theory is that although the traps were designed with a factor of safety of 5 a sudden surge was encountered which was over the trap capacity. This surge could have resulted from a higher steam demand which reduced the steam pressure at the trap, consequently reducing its condensate capacity. This allowed condensate to collect and freeze, bursting the tubes. This situation was corrected by installing larger traps away from the units so the pipes can act as a reservoir for any surplus of condensate the trap cannot handle.

Fig. 7 (top). General view of paint mixing room. Vacuum still for thinner reclamation can be seen in background.

Fig. 8. Booth and conveyor arrangement.

Fig. 9. No. 3 spray booth with centre partition removed and opened for entry of extra large parts.





On starting one unit, with no air being exhausted, hot air was forced up the intake stacks of the other units. This caused the controlling thermostats (owing to their location) to close the steam valves and cause a freeze-up.

In conclusion, after a year of operation, it can be definitely stated the installation has measured up to expectations. Quality has been vastly improved and there is little hazard in the operation of the area.

The overall cost of the project was approximately $60,000 and the annual savings due to decreased rejection and improved efficiency was estimated at $24,000. However, the latter actually amounts to $30,000 because of the increased work load which the area easily handles. Operating costs however, have increased slightly due to the additional oven and the vacuum still. Heating cost is approximately the same, as the amount of exhausted air has not increased appreciably.

Acknowledgements

Acknowledgements are due to: Ontario Department of Labour; Factory Mutual Engineering Dept.; Insurance Underwriters of Canada; and to the Plant Dept., A. Gibson, and S. Sillitoe, of Northern Electric Company Limited, Belleville Plant.

Fig. 10. Parts can be baked in conveyor oven or on trucks in batch oven, or air-dried in the large dust-free area. (Top.)

Fig. 11. No. 3 air replacement unit in monitor section of roof. Arrangement eliminates use of costly floor space.

Fig. 12. Control board outside the spray area. Each section is painted a different colour and switches are identified.

Fig. 13 (Below). Control panel of conveyor oven. Engineers check temperature charts of the oven.

Electrical Power Measurements

at the National Research Council

J. Hart

Division of Applied Physics, National Research Council

ENGINEERS and scientists are planning for a continuous expansion of the supply of electrical power, and technical journals are filled with papers on novel methods of generation, distribution and switching. Meters are very necessary adjuncts to our power systems, but their importance tends to be eclipsed in print by articles on more spectacular electrical matters; a highly specialized and important aspect of metering which is concerned with the art of standardization and calibration is all too often taken for granted, and this article seeks in some small measure to remedy this deficiency.

Power authorities, defence departments, meter manufacturers and similar industrial organizations maintain their own a.c. laboratories which contain excellent secondary instruments whose calibration is known to remain constant for many months or even years, and the comparison with the laboratory standard of meters from production or the field, perhaps through other intermediate instruments, can be carried out on an assembly line basis.

The calibration of precision laboratory master instruments is quite another problem, and may require considerable finesse. Many of the better equipped laboratories carry a group of standard cells, resistors and potentiometers for high precision d.c. comparisons, but it is very rare to find an even vaguely comparable precision in a.c. work: the reason for this gulf between a.c. and d.c. precision will become evident later in the article.

The power frequencies at which calibration facilities are made available depends on the nature of the industry: 60 cps. and 25 cps. are still overwhelmingly popular as general distribution frequencies, but the trend in airborne and other portable systems is to frequencies that would have been considered impossibly high a few years ago, and high precision calibrations at 4000 cps. are usual, if not commonplace. This state of affairs presents quite a challenge to the calibration laboratory, for it is a truism to say that the higher the frequency, the farther away the calibration gets from the d.c. standard cell and ohm, and the more difficult does the technique become.

The Applied Physics Division of N.R.C. is responsible for the maintenance of existing physical and electrical standards, and research into new ones. This paper describes the a.c. power measuring equipment that is being built in the electricity and mechanics section of the division.

Responsibility of N.R.C.

A uniform and true system of metering is possible only if the laboratory standard instruments, *including cells and resistors*, belonging to industries across the country are compared at regular intervals with master standards that are known to be accurate; it is precisely this function of correlation that the National Research Council is required by law to undertake.

This responsibility is not by any means confined to electrical standards and in the applied physics division very active research is being pursued into primary standards for all fields; a variety of industrial measuring devices ranging from gauge blocks through thermometers to nuclear radiation sources are accepted for comparison with our standards. These facilities are heavily used by industries with their own standardization laboratories, and by firms who specialize in calibration.

An absolute measurement is strictly speaking the direct comparison of a quantity with the basic standards of mass and length of which the National Research Council is the legal custodian, and time which is kept by the Dominion Observatory. Electrical units are established by a series of transfers in the electricity and mechanics section. Starting with a standard physically measured inductor used in a bridge at a standard frequency, it is possible to establish a standard resistor in terms of length and time to a few parts in a million. A standard ampere (d.c.) can be similarly established, with about the same precision in terms of the force between two coils of known physical dimensions (here, mass, length and time are involved). The standard ampere passing through a standard ohm establishes a standard d.c. potential which is readily available in a Weston cell. These standards of resistance and potential are portable and can be used for national and international calibrations and comparisons.

A. C. Standards

The problem of a.c. measurements is on a rather different plane. It is not, with present techniques, possible to make an absolute a.c. calibration since the quantity to be measured is of necessity transitory in nature. A practicable alternative is to derive primary a.c. standards of current, potential, and their product, power, in terms of the well-established absolute d.c. measurements. (A broad definition of a primary measurement would be a comparison made with the highest accuracy against an international or absolute standard).

It is now 60 years since electrical power was first measured with high precision and it is a great tribute to Kelvin and to far-sighted people like Rayner that the most precise measurement of a.c. power is still made with a quadrant electrometer that is substantially the same as Kelvin's original. This instrument, however, has disadvantages, and dynamometer or thermal converter instruments are necessary for some power standardization purposes. I shall explain the presence of these diverse types of instruments, some of very old design (but of excellent vintage), in the electricity section of the National Research Council's applied physics division, and follow that with a more detailed description of the equipment. This facet of the standardization facilities at the Council is a new, but very necessary development; the immediate objective is the establishment of a.c. power measurements of a quality equal to those of any other national standards laboratory; the industrial expansion of our country has made the continuing development of primary a.c. standards in Ottawa imperative.

In almost all physical measurements the most accurate result can be obtained if the unknown quantity is compared with the known one in such a way as to give a null upon a deflecting instrument. Unfortunately there is no single circuit which can be used in this way to compare a.c. and d.c. quantities with precision. It is possible to build a wattmeter which has two similar systems, one a.c. and one d.c. connected in such a way that the d.c. couple acts as an "electrical spring", and counteracts the a.c. deflecting torque so that when the a.c. and d.c. quantities are equal there is no deflexion of the detector. Electrostatic instruments have been made on this principle, and we have a dynamometer which can be so used.

In practice, however, complications are introduced by trying to set up such an instrument and the traditional method of making primary a.c. measurements is to use an instrument which has nearly the same response to d.c. and a.c. The amount by which a given d.c. current, voltage or power and the same a.c. quantity differ for the same indication of the instrument is the a.c./d.c. transfer error of the instrument at that particular frequency: a primary instrument is designed to have this error calculable and very small. It is always used in such a way that the same scale indication is obtained successively on both directions of d.c. and on a.c.: under these circumstances the transfer is independent of relatively slow mechanical and thermal drifts. Once the a.c./d.c. transfer error has been established, this information can be used throughout the lifetime of the instrument. As with any other standardization the proof that the transfer error is small can be demonstrated only by using more than one method of transfer, and it is for this reason that a well-established national laboratory uses several types of instruments. Once the a.c./d.c. transfer error of the primary standard instrument has been established the calibration of other a.c. instruments although not necessarily a matter of routine, is quite straightforward. This article is concerned mainly with power measurements, but the same principle holds for current and voltage measurements.

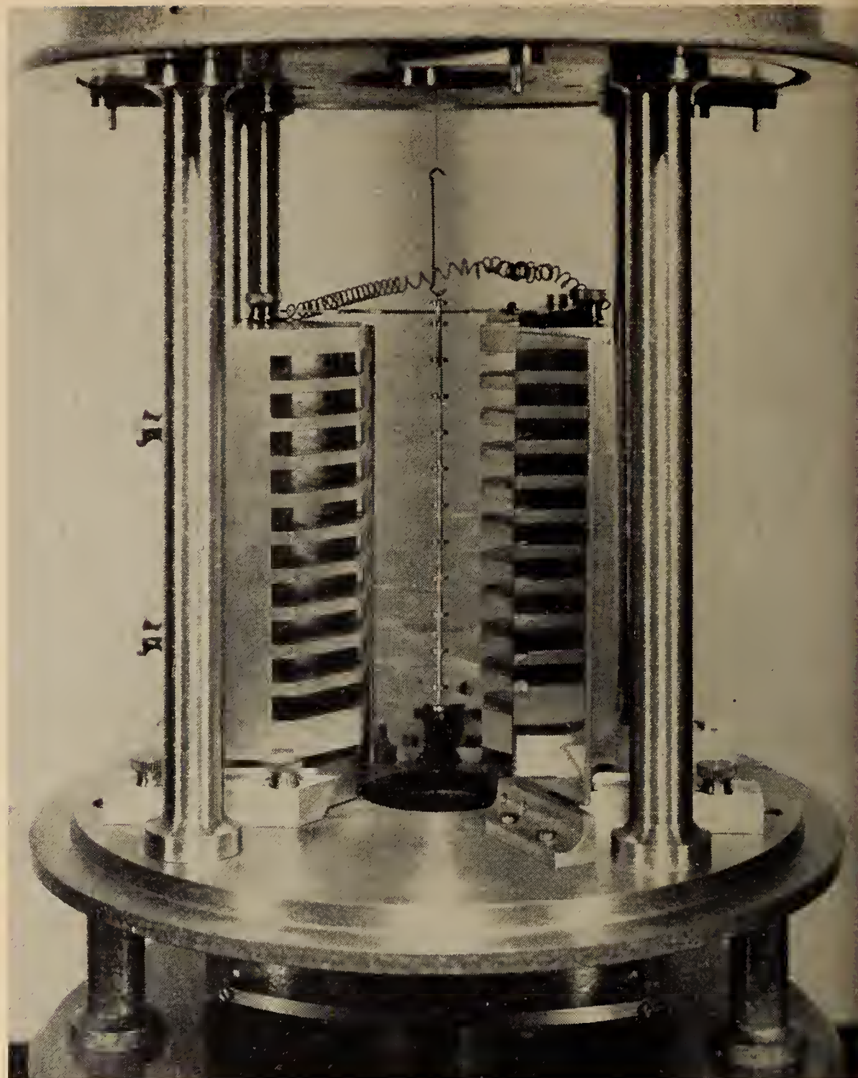


Figure 1. The Kelvin electrostatic voltmeter movement. The instrument has a bifilar suspension about two feet long. The mirror which is in the lower compartment is attached to the moving vanes by the metal rod. The fixed electrodes run on tracks, and their position determines the sensitivity and linearity. Construction is almost completely of aluminum: the main baseplate is about 7 in. in diameter.

Standard Laboratory Instruments

There are three main types of laboratory transfer instruments: (a) electrostatic, (b) electrodynamic, and (c) electrothermal. There is another reliable method of transfer so far used for potentials only; this involves the comparison of a.c. peak with d.c. voltages but it is of strictly limited application. Methods (a) and (b) can be made to depend upon the instantaneous products of two potentials or currents to a high degree of precision and are suitable for standard voltmeters, ammeters or wattmeters. Thermal or, more recently, luminous converters can be made to read power directly only by ingenious circuitry, so that they have not been widely employed as wattmeters. To measure power by thermal methods, independent precise measurements of potential and current have to be made using a pure waveform, with the additional complication of a very difficult phase angle measurement. All three types of instruments are capable of accuracies of better than 0.01 per cent when carefully used, at any power frequency. Each type of instrument has its own limitations and these will be discussed in detail.

The laboratory has deliberately been very conservative in the choice of instruments, for our immediate objective has been the rapid establishment of unimpeachable a.c. standards.

Electrostatic Instruments

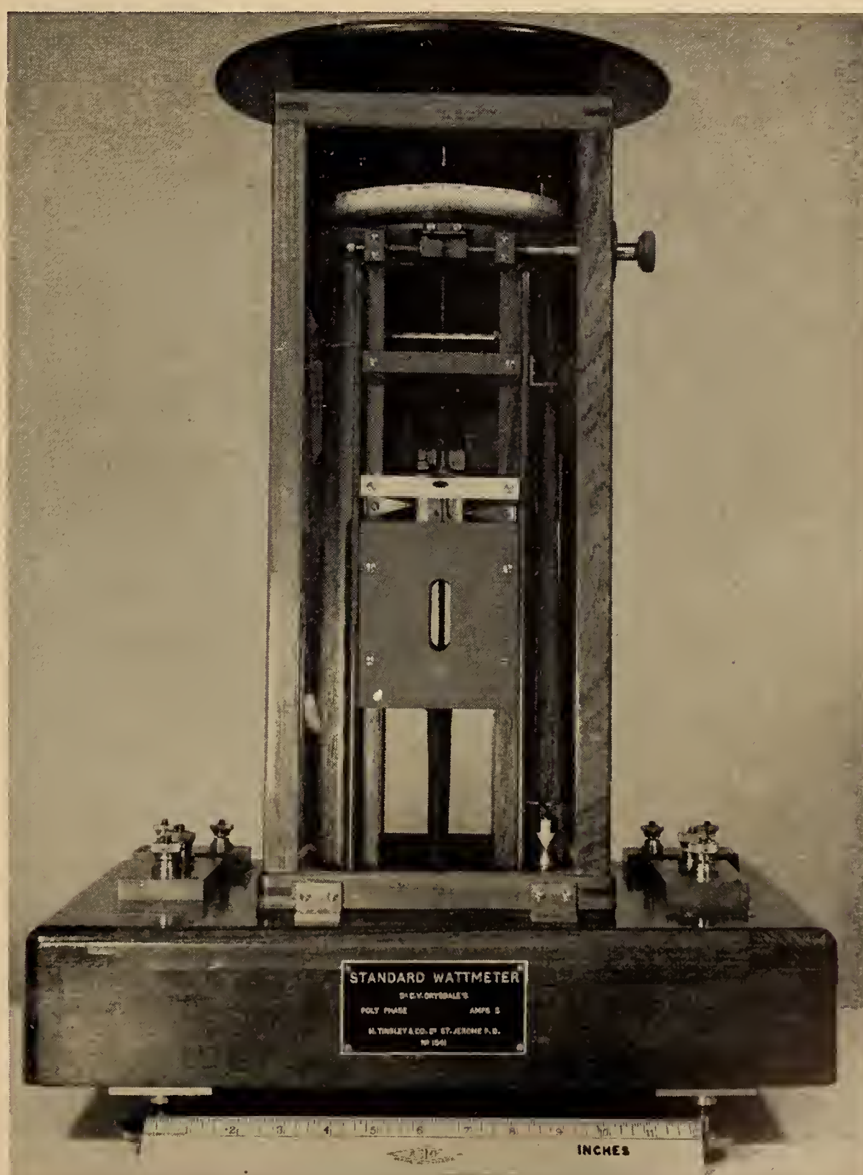
The laboratory has a Kelvin electrostatic voltmeter, and a quadrant electrostatic wattmeter based upon the British National Physical Laboratory design is being constructed in the physics workshop at the National Research Council. An electrostatic instrument is difficult to handle, since the torques developed are small and thermal or mechanical disturbances can be very troublesome. The voltmeter, which is a multiplate instrument with a bifilar suspension is less critical in this respect than the wattmeter, which has a very thin aluminized mica needle on a single wire suspension. Both instruments have optical pointers and are capable of an ultimate accuracy of the order of a few parts in 100,000. The full-scale deflexion of the voltmeter is 120 volts; the wattmeter requires a potential of 120 volts on the needle and about 2 volts on the quadrants obtained by dropping the current across an a.c. standard resistor; the indication is proportional to the integrated instantaneous product of these two potentials and therefore to average power.

Electrostatic instruments are of course essentially sensitive to differences of potential. They have practically zero inductance and small capacitance, so that they are transfer instruments *par excellence* at all audio frequencies, but small contact potentials may be troublesome. To reduce these, the same metal (aluminum) is used throughout and the machine finish is carefully controlled; despite these precautions very slight surface corrosion can exert a detectable rectifying action which increases the transfer error. The only way of removing this error, which may not be constant with frequency, is to subject the working parts to mild chemical treatment. In the past, electrostatic voltmeters with working parts of different metals with different finishes have been used to examine these effects in some detail and there is no necessity for us to repeat this work.

Electrodynamometer Instruments

The dynamometer is essentially a current-sensitive device and of necessity has appreciable inductance. The laboratory has two precision dynamometers, both with optical pointers. One has a high permeability core and has to be corrected with auxiliary capacitances for a.c. operation. Although capable of great precision it is not truly an a.c./d.c. transfer instrument since the transfer error is not

Figure 2. The Drysdale dynamometer wattmeter. Two pairs of fixed coils are perpendicular to each other and the moving coils are suspended from a torsion head by a spiral phosphor bronze spring. The moving coils are individually wound astatically, and as a result each pair of fixed coils has to be connected with the fields of the two individual coils opposing each other. The moving coil therefore moves in a far from uniform field. Construction is almost completely of wood and bakelite.



amenable to calculation and (without compensation) is large.

The other instrument, designed many years ago by Drysdale, has no iron whatever in its construction. It has two identical systems mechanically coupled and suspended by a spiral spring of phosphor-bronze, so that it can be used for two and three phase measurements and if necessary as a single phase a.c. instrument with a d.c. electrical spring. The interaction between the two systems is negligible, current-potential interaction is also small since the torsion head is adjusted so that the coils are always in a position of practically zero mutual inductance with respect to the fixed coils. The moving potential coil is in series with a resistive multiplier of relatively high value and the inductance of the coil is negligible; there are no large masses of metal or closed loops so that eddy currents are kept to a minimum; the a.c./d.c. transfer error is therefore small and calculable at frequencies up to a few kilocycles per second. The instrument is rugged compared with the electrostatic instrument, for the operating torque is relatively high, and it is invaluable for more routine calibrations. The precision obtainable is of the order of 1 part in 50,000 with 100 volts on the moving coil and its associated potential divider and 5 amp. through the field coils.

Thermal Converters

A thermal converter is essentially a filament of resistive material which is heated by the current to be measured; the temperature attained is read by using a thermo-couple or by some other method. Commercial converters are readily available and we use these without modification either in a self-contained transfer volt ammeter designed at the National Bureau of Standards or in our own circuits. In this laboratory, thermocouple potentials are compared on oil-filled microvolt potentiometers; no absolute measurement of the filament temperature is required when the converter is being used as a transfer instrument. The more sensitive converters are sealed in vacuo.

Thermal converters suffer from d.c. reversal errors if the thermocouple is not in the thermal centre of the heater, and they are inclined to drift fairly rapidly so that it is difficult to make a measurement more precisely than about one part in 10,000. On the other hand, they have a response right through the audio

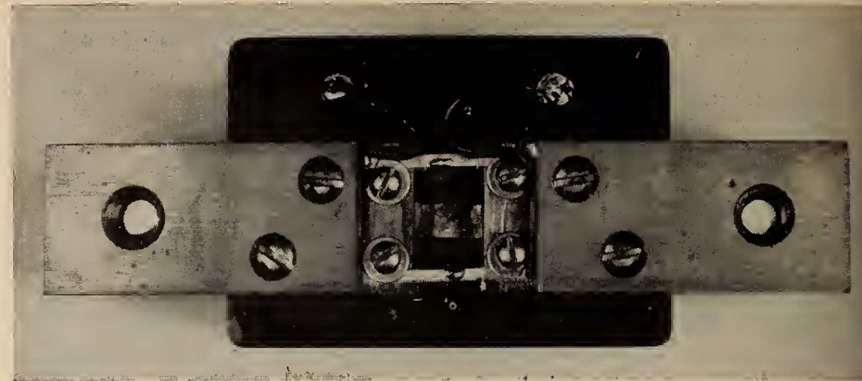


Figure 3. A high-current thermal convertor. The thermocouple is welded to the centre of the resistance element and is connected to the potential terminals via the two metal strips which are isolated by mica spacers.

frequency range for current between 5 ma. and 20 amp.; their self-inductance and capacitance are virtually zero. Precise measurements of power have to be made by measuring current and phase angle independently using a very pure sinusoidal waveform. This can be achieved without difficulty at unity power factor but the phase angle measurement becomes very difficult at lower power factors; we hope to develop a phase bridge which will be adequate for power factors down to 50 per cent.

Laboratory Equipment Is Flexible

Electronic generators supply the power source for calibrations. An audio frequency oscillator feeds three audio frequency amplifiers by way of a phase shifter which controls the relative phases of the amplifier inputs. Single phase wattmeters are normally calibrated on phantom loading using two amplifiers to supply the potential and current respectively with a variable phase angle between them. The third amplifier is a standby which is paralleled into the current output for high current measurements and may also be used to supply a third phase if required.

The output from this equipment is 200 watts per phase, with less than 1 per cent harmonic distortion at frequencies between 200 and 20,000 cycles per second; amplitude drift is of the order of 0.2 per cent per minute and is the most troublesome feature of the generators. Potentials up to 1 kv. and currents up to 20 amp. are available.

In addition there is a 1.8 kw. self-contained single phase electronic generator with an output of 110 volts, 1 per cent distortion between 20 and 4,000 cycles per second. This is normally used to power the other three amplifiers at 75 cps. to avoid various complications that occur when they are powered directly from the mains, but it is available separately for calibrations requiring higher powers.*

The generators are mounted in standard racks together with a monitoring oscilloscope, phase meter and wave analyser, in front of which there is a low bench for the potentiometers and portable meters; the bench is narrow and the generator controls can be reached by people seated at the benches. The primary standard meters are mounted on wall brackets or other benches and the potentiometer, galvanometers for routine work stand on anti-vibration mounts in the equipment racks or supported by wall brackets.

Associated with the equipment already mentioned there are a.c. standard resistors in an oil bath, standard cells in an air thermostat, decade resistance boxes and capacitors. Direct current supplies are obtained from batteries in a ventilated cabinet, and the direct potential supplies come from a Glynn type stabilizer.

The laboratory is air-conditioned and is maintained at 72 degrees F., 40 per cent to 50 per cent r.h.

Calibration And Intercomparison

All the instruments described respond to d.c. and to r.m.s. a.c. when used to measure current and potential: the wattmeters respond to average power. These are the quantities which are normally of most interest, and they are not critically dependent upon the applied waveform provided that high order harmonics outside the range of the instrument are not present in large quantities.

The comparison of current voltage or power by an a.c./d.c. transfer requires the connection of the stand-

* Current and potential transformers used for high power work are calibrated in the National Research Council's electrical engineering section.

ard and other meter in a circuit with provision for switching between a.c. and both directions of d.c., which is itself standardized against a standard cell by ordinary potentiometer techniques. It is emphasized that the calibration is independent of the electro mechanical properties of the standard and depends only upon its a.c./d.c. transfer characteristics which are for all practical purposes constant and known. Errors caused by effects like the self-heating of a potential coil are examined separately.

The measurement of power by thermal methods is difficult and is still in the experimental stage. Thermal wattmeters which are usable throughout the audio frequency range are not high precision instruments. It is possible to measure current and voltage separately and the phase angle between them, but in this case the apparent power is given by the product of the r.m.s. current and voltage and the power factor and this is not the true power unless current and potential wave forms are sinusoidal. The precision is limited by the waveform of the generator and the accuracy of the phase angle measurement.

Future Work Depends Upon Demand

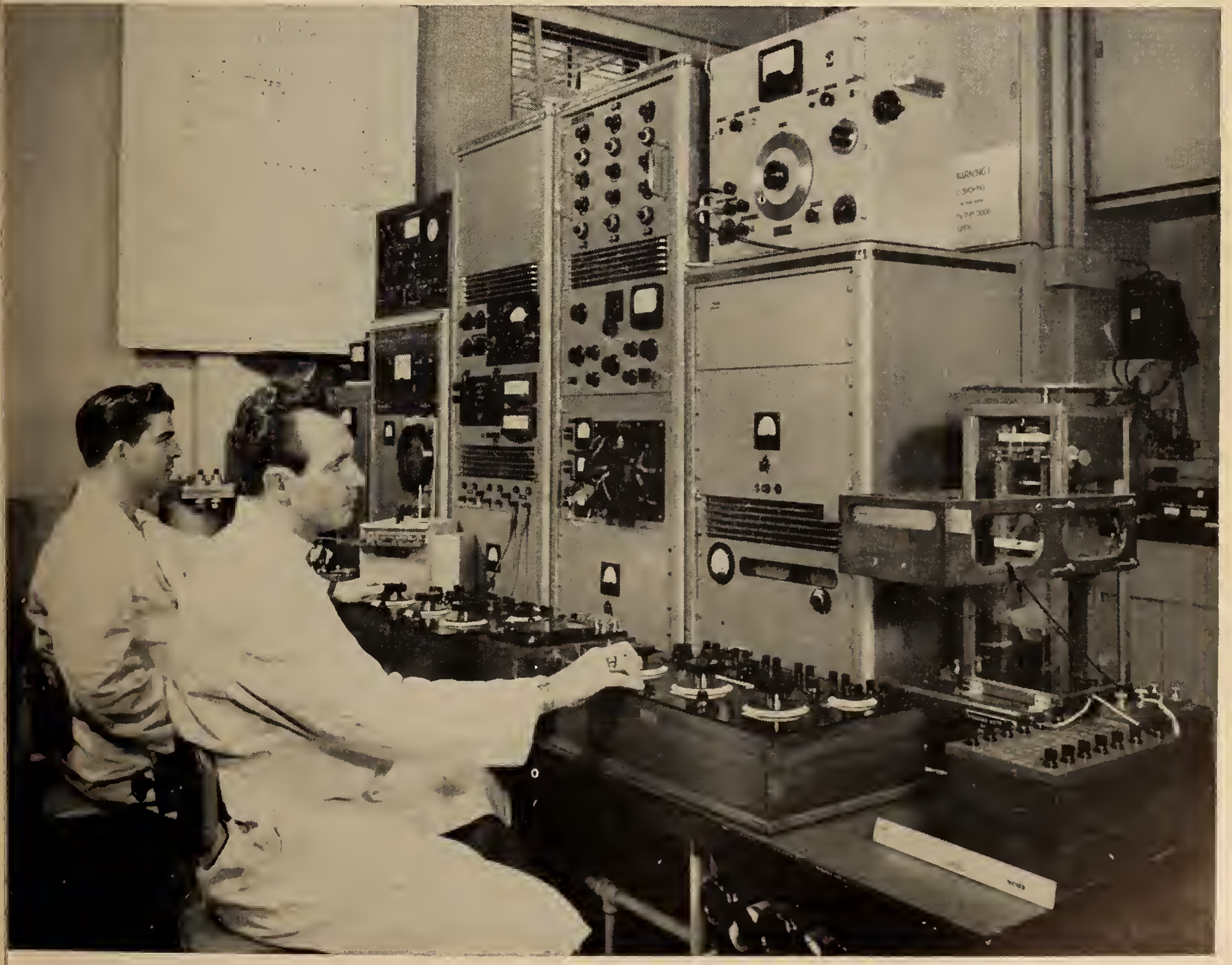
Ever higher power frequencies are being used in diverse applications, ranging from missiles to induction furnaces and we intend to devote a considerable part of our energies to the study of new methods of power measurement that can be used at these elevated frequencies. The demand upon the a.c./d.c. transfer system will increase at "ordinary" frequencies and we know that the country's standard rests upon a sound classical foundation.

In spite of the vast improvement in standardization techniques and calibration facilities in the last few years, there are still too many instruments in the country in which the users have completely unjustified confidence. It is our hope and duty to encourage every meter user to confirm the calibration of his instrument at regular intervals, whether he be interested in illumination, photogrammetry or, in our case, electricity.

It is our function to calibrate laboratory standard meters from commercial standardization laboratories. It is not our function to calibrate quantities of ordinary meters for industry; these may be sent to firms who specialize in that business, or, in appropriate circumstances to the Department of Trade and Commerce. They

(Continued on page 290)

Figure 4. A general view of the calibration racks. The 1.8 kw. power supply is hidden at the far left: the next rack contains a distortion monitor, the phase meter and an oscilloscope. The phasc bridge, output monitoring meters and one 200 watt amplifier are in the centre rack. From top to bottom in the fourth rack are the phase shifter, oscillator, ac/dc switches and the second amplifier. The fifth rack carries the wave analyser, the third amplifier and the d.c. galvanometers. On the bench arc the thermostat containing standard cells, a portable wattmeter, two potentiometers, an a.c. volt box and a primary wattmeter. The heavy batteries are in the cupboard behind the racks. A heavy duty oil cooled standard current shunt can be seen between the technicians.



An appraisal of the potentiality of

High Voltage D.C. Transmission

E. V. Leipoldt, M.E.I.C.

Vice-President, The Shawinigan Engineering Company Limited, Montreal

Based on papers read at meetings of the Atlantic Provinces Professional Engineers, St. Andrews, N.B., September 1956, and the Engineering Institute of Canada, Montreal Branch, October 1956.

TECHNICAL interest in the possibilities of long distance transmission of power by high voltage direct-current has been sustained for over half a century. This continued interest is somewhat puzzling in view of the meagre accomplishments in this field to date. Only two relatively small installations, both government sponsored, have been recently constructed after a lapse of some 60 years since the so-called Thury system of d.c. transmission was commissioned in 1890.

The Thury system was based on constant current transmission at variable voltage. The high voltage was attained by connecting a number of d.c. generators in series with insulated bed plates and drive shafts. To utilize this power at the receiving end of the line, the motors were similarly arranged. It is obvious that this system had limited application and it was used to a degree only in North America on d.c. traction systems at 2500-3000 volts. Subsequently these d.c. generators were replaced by mercury arc rectifiers.

In order to place it in the proper perspective and historical background, it should be observed that the Thury system was initiated in France during the period that the polyphase alternating-current system and the induction motor were being developed in America and in Europe. From this point on great strides were made in the perfection of a.c. motors, generators and transformers, and transmission of power by high voltage a.c. soon took the lead, a position it has never relinquished. As the magnitude of power to be transmitted and the required transmission distance have increased with time, technique in the design and construction of a.c. equipment and lines has kept pace and thus far imposed no limitation on practical requirements. Several systems in European countries are now operating at 400 kv. and new lines are being projected for 500 kv. In these upper ranges of transmission voltage, a single circuit line would be capable of transmitting a million kilowatts over a distance of 400 to 500 miles. Capability of this order should satisfy all practical requirements in the foreseeable future.

Where then does d.c. transmission enter the picture as a possible contender, and why has interest been maintained in d.c. transmission in the face of such overwhelming achievements in the a.c. field? The answer may be found in technical criteria which favour the use of d.c. and which have stirred the imagination of many eminent engineers. Some of the leading manufacturers in Europe and the U.S.A. have spent millions of dollars in research and on the construction of experimental lines to demonstrate the practicability of d.c. high voltage transmission. With possibly one exception, these companies have all abandoned active development in this field due to the apparent limited application of d.c. transmission to the rapidly expanding network of a.c. lines which cover most industrialized areas.

Technical Comparisons

A review of some of the technical advantages which the d.c. system offers in comparison with the conventional a.c. transmission system is given hereunder.

(1) *Conductors* — Self-induction of alternating current creates the so-called "skin effect", the crowding of current to the periphery of the conductor. The economical utilization of metal for conducting heavy alternating currents suggests the use of a hollow core conductor, unless mechanical or other considerations apply, such as steel reinforced aluminum conductor. The smaller diameter of conductor, permissible for direct current of equal rating, is of particular significance in the comparative cost of submarine cables.

(2) *Insulation* — Since the nominal or effective voltage of alternating current is the r.m.s. value of the sinusoidal voltage wave, it is apparent that all insulating materials will be subject to stresses equal to the peak value of the wave. This factor of approximately 1.4 of the effective to the peak values of a.c. voltage permits a corresponding lowering of the insulation levels for d.c. transmission lines and cables of equivalent voltage classification. A further reduction in the thickness of paper insulation for d.c. cables is permissible due to the unidirectional stress imposed by the d.c. voltage.

(3) *Submarine Cables* — The capability of any submarine cable to carry the rated ampere load for which it has been designed is governed mainly by thermal considerations. The energy loss generated in the conductor must be dissipated through the insulation, the sheath and the mechanical armouring at a temperature gradient which would not exceed specified temperature limits at the surface of the conductor. When alternating current is transmitted, certain other losses, in addition to that of the conductor, must be accounted for in calculating the ther-

mal flow. There are, for example, the dielectric loss in the insulation caused by alternations of the direction of stress; induced circulating current losses in the metallic sheath; and electro-magnetic losses in the external steel armouring of the cable. None of these supplementary losses applies to d.c. transmission; moreover, the reduced radial thickness of the insulation belt (item 2) permits a greater transfer of heat, or conversely a lower temperature at the surface of the conductor.

(4) *Transmission Lines* — The construction of a transmission line for high voltage d.c. offers a simpler solution in structural design than a conventional three phase a.c. transmission line of comparable voltage and transmission capacity. The two-conductor d.c. system with grounded midpoint, relatively shorter insulator strings and smaller tower clearances (item 2) permits the use of a simple and compact steel mast with ground wire at the apex and balanced side arms carrying one conductor on each side.

(5) *Transmission Stability* — For comparative purposes, the electrical stability of the transmission system may be considered in the following two cases. The first concerns the long distance transmission of a large amount of energy from a generating source to a load consuming area; the second concerns the transmission of a limited amount of energy from one large power system to another. In the first case with a.c. transmission, instability may arise due to a disturbance in the connected load system causing a momentary drop in voltage or frequency. In the second case, overloading and resulting instability of the tie line may occur due to a sudden loss of load or of generating capacity in either of the two major systems, with resultant differences in frequency and voltage. The d.c. transmission system is inherently stable as it is independent of frequency and of voltage fluctuations of the connected a.c. systems. It will tend to maintain the power flow for which it has been adjusted, provided the connected a.c. systems are able to supply or absorb the energy transmitted. The d.c. tie line is also an effective method of inter-connecting two a.c. systems of different frequencies for the interchange of power.

(6) *Line Capacitance* — In long distance a.c. lines, and particularly in the very high voltage ranges, the line charging current due to the capacitance effect presents a serious operating problem in many respects. Unless compensated by the switching of shunt reactors in the line, it imposes special requirements in the generator design, complicates the regulation problem and requires higher insulation at the line terminal for open circuit conditions. In long a.c. high voltage cables, this condition becomes more severe, since the charging current may easily exceed the normal load current. The line capacitance has no similar effect on d.c. transmission. Compensating equipment with associated losses must therefore be considered an added burden to the cost of a.c. transmission of large blocks of power.

(7) *System Fault Currents* — When a system with large concentration of power is connected to a smaller system by an a.c. tie line, a substantial increase in the magnitude of fault current of the smaller system results. This condition seriously affects the interrupting ratings of circuit breakers on the smaller system. The d.c. tie line, on the other hand, contributes in short circuit current little more than the nominal rating for which it has been adjusted. A supplementary increase in fault current may arise however from the synchronous condenser capacity required to supply the reactive component on the load. The combination of these two will still be much less in effect than that resulting from an a.c. line of comparable capacity.

The author discusses advantages and drawbacks to the use of high voltage direct current transmission, with particular reference to some of the experience gained in Europe. Transmission at operating ranges of some 200 kv. is commercially feasible.

Consideration of the foregoing technical advantages indicates that items (1) to (4) inclusive have a most significant bearing on the economy of d.c. transmission, particularly where long submarine cables form a part of the transmission system. In view of these apparent advantages of d.c. transmission, the question may well be asked: why has so little use been made of this practical means of reducing the cost of long distance-power transmission?

The answer is simple. The economical "break-even" point for long distance a.c. and d.c. transmission of large blocks of power is considered to be approximately 400 miles. While few lines have been constructed or even considered for this length, it is apparent that present experience with d.c. transmission lies on the wrong side of the fence. Not many engineers would be willing to assume the risk of making the large capital commitments necessary for a million or more kw. transmission scheme based on the now available performance data of relatively small capacity d.c. systems.

The cost of the a.c. to d.c. conversion equipment at each end of the line remains a formidable item, also the design and construction of the converters and associated control gear are more complex than the conventional equipment required for switching a.c. lines. Many utility engineers fear that the added complications would require a much higher order of technical skill and training on the part of their operating staff.

An appreciation of the general design features and operating principles of the d.c. transmission system may be helpful at this stage in appraising the prospects and potentiality in regard to future developments of the power industry.

Direct-Current Conversion Equipment

The converters which transform the a.c. to d.c. are, in principle, similar to the mercury arc rectifiers so extensively used for electrolytic purposes and for electric railways. They are reversible in their functions so that power can be transmitted in either direction, i.e. the converter can become the inverter. This is accomplished simply by shifting over a range of 90 electrical degrees the controlled pulses to the grids, which time the firing cycle of the valves.

Each converter station contains a number of valves arranged in groups of six connected to a three phase circuit with the anode and cathode forming the negative and positive d.c. supply. The connections are so arranged that each phase discharges alternately through one of two connected valves with each reversal of current, thus giving six d.c. pulses per cycle (see Fig. 1). Where two groups of valves are used in series, the second group could be connected to a separate transformer winding having a 60 degree phase shift. This gives twelve d.c. pulses per cycle and reduces the ripple effect in the d.c. circuit.

Each rectifier valve is so designed that it allows current to pass in one direction only. The main body of the valve consists of a steel shell supporting one or more insulated anodes at the top and contains a pool of mercury at the base which forms the cathode. A control grid, separately excited, is supported between the anodes and cathode, and serves to regulate the power through-put by advancing or retarding the ignition.

Whereas rectifiers for industrial use are of relatively low voltage and capacity, the valves for high voltage d.c. transmission must necessarily be designed for much higher voltages in order to transmit economically large amounts of energy. Individual valves are at present in operation at a nominal 50 kv. and experimental units for over 100 kv. have been designed and tested. At these higher voltages, the rectifier valves have a transmitting efficiency of approximately 99.8 per cent.

D.C. System Operation and Control

The principles employed in the control of d.c. transmission systems contain elements that are novel to the operator of conventional a.c. systems. For many years the relative merits of constant voltage versus constant d.c. current have been debated. At present, the constant voltage system appears to have gained the upper hand, and the control procedures described herein are based on this method of operation.

First of all, it must be understood that a d.c. transmission system, with its complement of terminal equipment, converters and inverters, cannot function unless there is a source of a.c. voltage available at the receiving end. This voltage may be derived from a synchronous condenser or a power network, the former being normally required to supply the reactive component of the inverter station. The reactive requirements amount to approximately 50 per cent of the energy transmitted, or the equivalent of an 85 per cent power factor at the receiving station.

This reactive requirement is due to the "margin of commutation", i.e., the time interval between the selected firing point on the phase voltage wave and the instant where the incoming and outgoing phase voltages are equal. If this margin is reduced to a minimum, there is a possibility that one of the valves may fail to "commutate", resulting in a short-circuit of the d.c. supply. Increasing the margin of commutation improves the stability of the inverters but also increases the amount of reactive power which must be supplied.

The transmitting station is normally set to maintain a predetermined d.c. voltage by regulation of the on-load tappings of the main transformers. The receiving station, on the other hand, takes over the function of control of the frequency and current, i.e. the load. However, the control functions and responses of the sending and receiving stations are complementary, and it is therefore essential to connect the stations by a radio link or pilot wire for transmitting the control signals.

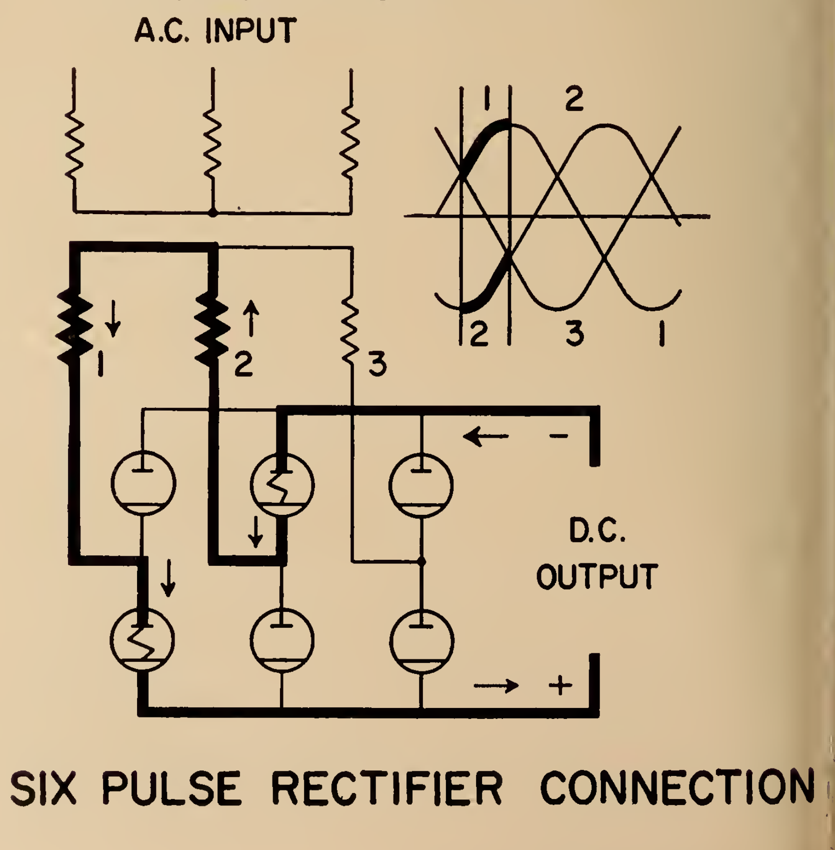
Where the d.c. transmission line is the sole source of power supply for a load area, regulation of the a.c. system voltage is accomplished by adjustment of the field of the synchronous condenser, precisely as in the case of a single generator supplying an isolated load. Power flow to the a.c. system is regulated by means of a frequency sensitive relay, which transmits "raise" or "lower" signals to the sending station when the system frequency deviates from normal. The transmitted signal is transferred through a relay which adjusts the grid control to raise or lower the d.c. voltage supplied by the rectifier, and actuates a follow-up relay to check and re-adjust the transformer taps to maintain the required margin of control on the grids.

For the alternative condition, where a d.c. line supplies power to an a.c. network having its own generating plant, the supply is controlled by a d.c. current regulator which can be adjusted to limit the amount of power transmitted. The d.c. supply will simultaneously assist in maintaining the system frequency by means of the frequency relay, but only to the extent that the maximum pre-set load is not exceeded. In the event of failure of the carrier or radio signalling system, the converters at the sending end continue to regulate for constant d.c. voltage, whereas the inverters automatically take over frequency or load control but under less favourable conditions.

Economic Studies

The capital cost of the terminal installations only for d.c. transmission has been recently considered to be in the order of \$40 to \$50 in Canada per kw. of transmission capacity. If this were to be expressed in terms of physical assets, the conversion

Fig. 1. Six pulse rectifier connection. Passage of current during interval between vertical lines on phase voltage curve is shown by heavy lines in diagram.



equipment for one million kw. transmission capacity would equal the cost of two separate 400 kv. three-phase a.c. lines approximately 250 miles long and capable of transmitting the same amount of energy. However, due to recent improvements and refinements in the d.c. converters now operating, it is anticipated that manufacturing allowances for development work could be shaded, with resultant lower prices to the industry. Reports from Japan(1), where d.c. converter stations have been installed for interconnecting their 50-cycle and 60-cycle systems, indicate a considerably lower cost for the conversion equipment as the "break-even" point in comparisons between a.c. and d.c. transmission costs is estimated to be 200 miles compared with the European estimates of approximately 400 miles.

Exhaustive studies have been made to establish an acceptable basis for comparison of costs for d.c. versus a.c. transmission. Assumptions have been postulated and examples calculated on a prescribed basis, covering a range of loads from 100 to 1500 Mw. and distances from 100 to 1000 kilometres for overhead lines, also 30 to 100 kilometres for submarine cables. The work (2) was undertaken by an international Study Committee appointed by the International Conference on Large Power Systems (CIGRE) and presented in report form (No. 417) at the Paris Conference, June, 1956.

Using European costs for line construction and conversion equipment, the "break-even" distance for overhead lines varies from 320 miles to 380 miles. The applicable distances for submarine cables are 22 miles for 750 Mw. and 18 miles for 100 Mw. It may be assumed that the "break-even" point would be somewhat greater in Canada due to the higher landed cost of conversion equipment.

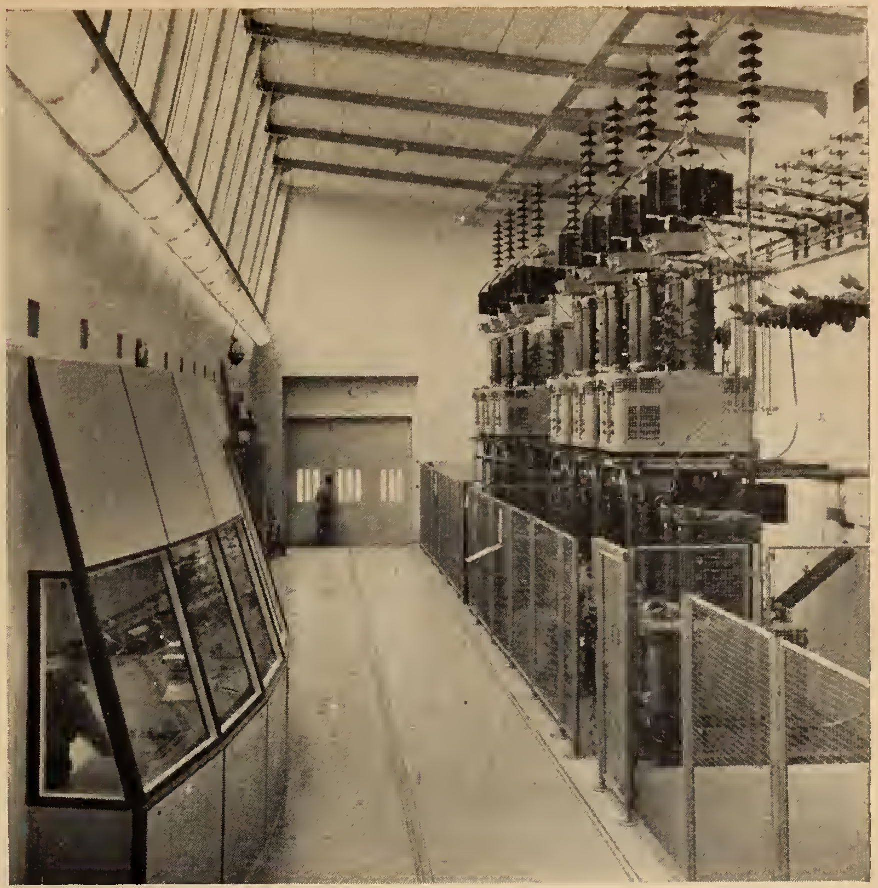


Fig. 2. Converter installation for the Gotland system. Rated output 20 Mw. at 100 kv., d.c. The two groups of rectifier valves are referred to in the text below.

Operational Experience

The Gotland scheme (60 miles of submarine cable) was constructed in two stages and operated for some months at 50 kv. with one set of valves. After the installation of the second group, the voltage was raised to the nominal rating of 100 kv. for an output of 20 Mw. over a single cable with return through the earth. Ultimately, a second cable will be laid and the installation duplicated to give 200 kv. between positive and negative and a transmission capacity of 40 Mw. Since the spring of 1954 when the system was placed in service, there have been two cable failures, one of which was due to a ship's anchor fouling the cable.

It was anticipated that the major source of trouble would arise from "back-firing" of the rectifier valves. This fault condition is provided for in the layout by the addition of a bypass valve for each group of six, which would shunt out the defective valve. This operation reduces the voltage to half normal and permits the valve to recover in a fraction of a second and be restored to service with a barely perceptible flicker. Figure 2 illustrates the two groups of rectifier valves at Gotland.

Experience to date has been more favourable than anticipated. Less than 10 "back-fires" have occurred during the first year of operation. The ageing of the valves, due to the deposit of metallic dust on the insulation, also has been less than expected and it is now believed that five years' continuous operation can be obtained before it is necessary to open the valves for removal of the deposits. A number of minor troubles in the secondary and control wiring have been eliminated and adjustments made to the regulating devices, which may be considered part of the normal "tuning up" operation of any newly developed equipment. This d.c. system is now considered so reliable that the thermal generating station on the island of Gotland has been shut down and the entire supply is taken over the single cable.

Russia has also been able to contribute information submitted in report form (3) to the CIGRE Conference. This covers the operation of an experimental-industrial 200 kv. d.c. transmission system. This d.c. system was commissioned in 1950 and supplies 30 Mw. to the Moscow power system from a generating station 70 miles away over two buried cables. The valves used in this installation are single anode type rated at 100 kv. and are arranged on an insulated platform which is normally grounded. In the event of a cable failure, the midpoint grounding is removed and the full output at 200 kv. is transmitted over the sound cable. The equipment and line were subjected to various artificial faults for development purposes and a number of improvements made which have resulted in stable operation. It is reported that the system operated with only three minor faults during 1955 and for a period of over 1000 hours continuously without an incident.

New Projects

With the recent signing of an agreement for transfer of power between the Central Electricity Authority of Britain and the Electricité de France, the Channel transmission scheme is now being actively developed. The d.c. system is favoured on account of the magnitude of the two networks to be connected by a relatively weak tie. The d.c. committee studies, previously referred to, would indicate that this installation would be a marginal case from the economic viewpoint.

Russia is definitely embarking on a large d.c. scheme for transmission from Stalingrad to Donbass to be completed by 1960. The voltage proposed is 400 kv. but no reports have been published as to the projected capacity of the line.

In Japan considerable progress has been made in d.c. transmission due to the two frequencies (50-cycle and 60-cycle) in common use and the necessity of cable crossings to the various islands. Several schemes are being actively studied and the manufacturers have produced suitable rectifier valves in ratings up to 100 kv.

Conclusions

(1) The design and construction of the d.c. conversion equipment, in the operating range of 200 kv. between positive and negative poles, has been demonstrated as a commercial proposition with normal expectancy of satisfactory and economical operation.

(2) Transmission of large amounts of energy in the order of 1000 Mw. or more from point to point and which would require an operating voltage of 400 kv., is still in the unproven stage. Unless government sponsored schemes are developed and operated to provide the necessary background, it is unlikely, that private industry would be prepared to finance the experimental installations and trial operating period which must precede the actual capital commitments for the construction of the d.c. transmission system.

(3) Transmission by underground or submarine cable, or where a cable forms part of the transmission system, is a field in which the application of d.c. could be advantageous for several reasons. If the distance is such as to make d.c. the economical choice, the d.c. system offers additional reliability for continuity of service. With a single circuit for both a.c. and d.c., failure of one cable or a conductor would reduce the d.c. transmission to 50 per cent of the rated capacity, whereas a similar fault on a.c. would cause a total interruption. Provision could also be made to increase temporarily the d.c. capacity by reconnection of the converter circuit, if one cable is out of service for an extended period.

(4) Direct-current transmission is decidedly advantageous for a tie line between two large systems on account of its inherent stability under system fault conditions and due to its limited contribution to system fault currents which affect circuit breaker ratings.

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Ground Temperature Investigations in Canada

(Continued from page 269)

but not without a significant margin of error; this should be reduced as more data become available. The success of theoretical study, directed toward a basic understanding of the problem, will depend on the development of ability to measure correctly the thermal properties of the ground, to deal with the complications of moisture flow, and to assess properly all the relevant climatic influences. It is in this direction that the studies of the Division of Building Research are now proceeding.

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Electrical Power Measurements at N.R.C.

(Continued from page 285)

send their standard instruments to Ottawa and we issue to them a routine form of report.

Problems which arise from the introduction of high precision instruments with unusual or novel characteristics should be discussed before the calibration is started: it is essential that the ultimate actual user of the instrument should take part in the discussion.

Finally, I should like to emphasize that the only primary Canadian calibration standards are those maintained by the National Research Council in Ottawa. It is a major part of ou[r] responsibility to make internationa[l] comparisons and this we achieve b[y] a regular exchange of tangible standards like the ohm. We define ou[r] own power measurements in term[s] of these standards and this is [a] function that must of necessity be carried out by one authority alone.

The Product of the Engineering Baccalaureate Curriculum

A panel discussion held as Session 2 of the joint Conference of the American Society of Mechanical Engineers and the Engineering Institute of Canada, University of Western Ontario, October 1956

G. Ross Lord

Head, Dept. of Mechanical Engineering, University of Toronto.

Moderator of the Session

The Panel members at this Session are: J. T. Rettaliata, president, Illinois Technical Institute; A. M. Anderson, manager of technical education, General Electric Company, Schenectady, N.Y.; E. T. W. Bailey, combustion engineer Steel Company of Canada; Professor S. Lauchland, head, department of engineering science, University of Western Ontario.

President Rettaliata describes the operation of his institute in considerable detail showing that his facilities (not necessarily staff) are employed from about 8:30 a.m. to 10:00 p.m. five days a week, 12 months a year with good results. In fact if it were not for the extra hours used per day, it would not be possible to operate at all. The undergraduate student has a well rounded program of fundamentals and humanities in his early training, with analysis and design added in his final two years. Most of the post-graduate study is done in the later afternoon and evening.

Mr. Anderson contrasts the work of the engineer with that of the scientist. Where the engineer uses knowledge to improve the lot of man, the scientist is adding to the store of knowledge. He also distinguishes lore from knowledge and understanding, and shows how all these factors may be combined to show how the engineer fits into the world of industry. Research, both basic and applied, require a discipline oriented engineer with post-graduate study qualifications. Mr. Anderson has conducted an interesting study of his own to see how engineers compared with liberal arts graduates concerning personality conflicts with others as a measure of their command of English. There was no detectable difference between the groups.

Mr. Bailey examines two aspects of university education. All year operation *v.* two-term operation, and the special (i.e., civil, electrical, mechanical) option *v.* a general course.

Professor Lauchland has the unique position of designing his own engineering curriculum for the new engineering sciences course at Western. He is also greatly concerned with this same problem of general *v.* special courses. What evolves at Western will be very interesting.

John T. Rettaliata

President, Illinois Institute of Technology, Chicago, Ill.

The recent report of the ASEE Committee on Evaluation of Engineering Education states "the ultimate goal of engineering education is the development of able and responsible men" who are "fully capable to practice on a professional plane, especially those who will lead the profession to new heights of accomplishment through creative practice or research."

Of course, this goal is stated from the point of view of the engineering profession and its educators, but all discerning people understand that its achievement will create necessary and useful individuals for the times in which we live.

The advancement of civilization, our standards of living, and even the preservation of life, are so dependent upon our industrial system that "the products of our engineering baccalaureate curriculum" will have a great effect on the future of mankind.

Predictions from informed sources reveal a future economy for the United States of almost limitless proportions. Each successive year, forecasts indicate, can be a better year. Such optimistic prognostications are certainly pleasant to contemplate. But, it must be understood that the kind of economy being prophesied cannot be attained with the now conventional methods of operation. Because of this, we will be wise to attempt a forecast of what will be needed from the engineer in the future and determine how the products of engineering education may be best prepared and accommodated.

In the United States, it is now expected that the population, now about 168 million people, will double in 50 years; the gross national product, now 400 billion dollars, will double in 25 years; and that electric energy production will double in 10 years. This tremendous expansion anticipates the use of new methods and new adaptations of more of the natural resources. The need for more research to develop new knowledge, and to apply it, is obvious.

Since implementation of these things must originate in the minds of men, the individual who is equipped to achieve the increased productivity that is necessary to our future existence is the key to their accomplishment.

The scientist and the engineer must bear the major burden in bringing into reality the potential in store for us. Competent management, as always, will also be invaluable in furnishing the medium through which creative forces ultimately produce a useful result; but the basic dependence of the economy will be upon science and technology.

Hence, continued progress will be contingent, primarily, upon an adequate supply of qualified scientists and engineers. We must not only produce more scientists and engineers but we must especially strive to develop creative men who will be able to make the greatest contribution toward reaching our future objectives. As we approach the area of diminishing returns in the effectiveness of existing procedures and processes, the thinker becomes increasingly important.

As always, the magnitude of our advancing stride will be dependent upon the human dimension, not the mechanical. The various new aids at our disposal — such as electronic computers — remarkable as they are, cannot think. Their effectiveness is related to the competence of their conceivers and operators. If we are to meet the challenge of the tremendous task ahead, we should make most effective use of gifted individuals and stimulate the creativeness of every future engineer.

The frontiers of science and technology are now advancing more rapidly than at any previous time in history; many will be reduced to routine engineering practice within a few years. The future engineer will have to recognize new developments that have significant potentialities in engineering. Indeed, the rate at which new scientific knowledge is incorporated into engineering practice will depend upon the engineering graduate's capacity to understand new science as it develops. We must facilitate this translation into practice by emphasizing the unity in scientific subject matter to the future engineers now in the classroom. When a student understands there is a great deal of similarity among the generalizations of heat flow, electromagnetic fields, mechanics of fluids and vibration theory, for example, he will gain a concept of systematic orderliness in many fields of science and engineering; he will know how to solve problems in widely diverse fields, with the same basic methods.

Because new situations will arise continually, engineering educators must help students to learn how to deal with each of the situations in terms of fundamental principles, on their own initiative, with self-confidence and sound judgement.

The future engineer must not only be a competent professional but also a well-educated man, with understanding in the humanities and the social sciences as well as in his own field. He will need to be able to deal with the economic, human, and social factors of his professional problems.

An increasing number of engineers are progressing into managerial and top executive positions in industry and government. As manufacturing becomes more complex, and industrial research more common, the proportion will grow. Such men must get their original preparation on the campus. Their future ability will be influenced by the extent to which their technical education is broadened, and perspective and judgement sharpened.

Considerable thought has been given in recent years to the curriculum pattern in the technological institutions to produce the better engineers needed in the future.

Most engineering educators are in agreement that scientifically-orientated curricula which emphasize the basic sciences, the fundamentals of engineering, and which provide for the integration of courses in the humanistic and social sciences should produce the best product. These educators are seeking time to fit into the tight class schedules the opportunity for more students to enroll in more elective courses. They are also concerned about the performance of students in the communication of ideas.

Specialization

For many years, the curricula have been split by the occupational objectives of students who want to specialize because students do have varying interests and will serve different functions in society. We must produce such diverse personalities as production men, designers, technical editors, engineering salesmen, patent attorneys, and promoters. Too much specialization is very expensive for the educational institution to provide and the too-specialized may risk his adaptability for future needs and cheat both himself and society.

The perfect curriculum is still a dream, but there is growing conviction that a good broad education in science and technology, engineering analysis and design, and certain non-engineering subjects is the best one.

The emphasis on fundamentals will result in an approach to unification of the various engineering disciplines. There will be less distinction between different engineering curricula through the bachelor degree level. The tendency will be toward having the majority of the program the same for all engineers, with those courses defining the major not exceeding several semesters out of the four years.

By keeping our engineering education fundamental in nature we should be able to help the employers of our product. For example, electrical, civil and mechanical engineers are too often regarded as specialists. The employer who insists he can consider only an electrical engineer for employment, for instance, will benefit — especially when there is a shortage of engineers — if he can use an adaptable mechanical engineer. It is obvious that, as basic science and engineering grow more important and intermingled, the educational institutions will be able to produce more graduates who are well-fitted to perform a variety of engineering duties.

Preparation for the engineering profession is receiving critical analysis, and only through continual self-examination will progress be made. Specialization is being gradually diminished in the undergraduate program, and is moving more appropriately into the graduate area.

For many years the bachelor's degree has been the accepted badge of admission to the engineering profession. But in a world of increasing complex technology, it is becoming more difficult to prepare a student adequately at the undergraduate level. If engineering is to remain a profession of stature, we might also reflect whether it, like the sciences, has now reached the state where a graduate degree represents the proper minimum preparation. It would appear timely to consider this if the student is to possess the proper fundamental background and also acquire some of the specialization needed to advance the practice of engineering. This is not a matter of concern only to educational institutions; the engineering profession itself must take a leading part.

Engineering and science will be hard pressed to meet the increasing challenge presented by our expanding economy. Alfred North Whitehead summed up the situation of our century as long ago as 1917 when he wrote:

"In the conditions of modern life the role is absolute . . the race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or sea, can move back the finger of fate. Today we maintain ourselves. Tomorrow science will have moved forward yet one more step and there will be no appeal from the judgement which will then be pronounced on the uneducated."

As science and technology move ahead, the product of our technological institutions must also move ahead — not only to keep pace but to set the pace.

A. M. Anderson

Manager of Technical Education, General Electric Company. Schenectady, N.Y.

Before I can provide adequate impressions of current engineering graduates, I feel it is quite important that we adopt a mutually understandable frame of reference against which we can measure these people. In establishing this reference, I will rely on some of the work done by Dr. D. E. Chambers of the General Electric Company although, of course, I am not speaking for Dr. Chambers in this connection.

First, I intend to dwell principally on matters relating to the graduate's understanding of physical principles and will devote little attention to the engineer's ability to read or write or get along with his fellow man. There are many popular and some ill-conceived notions in this latter category which are being espoused by many people but I would prefer to by-pass most of these at this time.

(1) Systematized fund of knowledge and understanding
(2) Lore

On the one hand is the systematized fund of knowledge and understanding which includes the physical principles which are utilized by these people. These are the descriptions of physical phenomena which have been proved useful over the years since they can be used to predict events when varied circumstances under which these events transpire are postulated. Some of the simple principles we know as things like Newton's laws, Maxwell's equations, the laws of hydrodynamic motion, etc. The second body of information is that of lore. These are the myriad bits of information which are largely uncodified and which some people include in the term "industrial arts." Included in this are the practices which have proved useful in making a product — practices which have been stumbled across quite by accident and which on the surface at least have but a very weak foundation in the body of understanding.

Now the scientist as he undertakes his work addresses his attention to increasing and further unifying the systematized funds of knowledge and understanding. In addition, as another example he attempts to transfer pieces from the fund of lore to the fund of knowledge and understanding. He is primarily motivated by a curiosity about physical things and a desire to synthesize new principles which will correlate observations and phenomena more succinctly. The engineer, on the other hand, is primarily responsible for extracting from the funds of understanding and the funds of lore to synthesize products and services which will satisfy the needs and wants of customers

During the second session. From left: E. T. W. Bailey; Prof. J. T. Rettaliata; Prof. G. Ross Lord, the moderator; Prof. J. Stuart Lauchland; and A. M. Anderson.

at the market place. However, either the scientist or the engineer in the process of doing his work might also and usually quite by accident does some of the things which the other generally does. For instance, it is not uncommon for an engineer to find in his work a different principle with a direct unifying ability and this in turn adds to the fund of knowledge. Conversely,it is not uncommon for the scientist in his explorations to perceive new products and services which can be sold at the market place.

It is necessary to go one step further in this description of technical work and outline the various facets of both research and engineering, the research work being dominantly a scientific endeavour.

Shown in the accompanying table are definitions of work — not necessarily of organization, although there are certain advantages in organizing the technical work approximately in this way. (Table on page 294)

From the foregoing it should be obvious that the body of knowledge and understanding which is studied academically by the engineer and the scientist should be roughly the same. Usually, however, the engineering educational institutions devote a little more time in their curricula to the industrial arts or the things which we have classified as lore although I personally believe this is not the correct thing to do and that these ingredients are better learned at work than in the classroom.

Now to the product of the current baccalaureate curriculum. In general the undergraduate excursion into the systematized fund of knowledge and understanding is roughly adequate to undertake the work of product design engineering, or some of the work of advanced manufacturing engineering, and of most of the work of application engineering judged in terms of the businesses of the General Electric Company. To undertake the advanced product engineering work, the advanced marketing engineering work, and some aspects of the advanced manufacturing engineering work, a greater penetration into this fund is required than one gets in the ordinary B.S. curriculum, and in general this means that graduate work or additional courses offered by the industrial enterprise itself are necessary to proper performance in these areas. In the research phases it is quite important that the majority of the professional people have an education level ap-

THE TECHNICAL WORK OF INDUSTRY

Research developing scientific understanding and obtaining scientific knowledge	➧	**Basic Research** developing scientific understanding of nature		**Applied Research** obtaining scientific knowledge about nature
Engineering applying understanding, knowledge and experience to determining, manufacturing, and marketing products	➧	**Advance Engineering** demonstrating technical feasibility	**Design Engineering** designing new products, processes and applications whose technical feasibility has been proven	**Production Engineering** improving existing products, processes and applications
▼		▼	▼	▼
Product Engineering demonstrating feasibility, designing and adapting the product	➧	**Advance Product Engineering** demonstrating the technical feasibility of new products	**Product Design Engineering** designing new products whose technical feasibility has been proven	**Product Production Engineering** adapting existing products
Manufacturing Engineering demonstrating feasibility, designing and modifying the manufacturing process or equipment	➧	**Advance Manufacturing Engineering** demonstrating the technical feasibility of new manufacturing processes or equipment	**Manufacturing Design Engineering** designing new manufacturing processes or equipment whose technical feasibility has been proven	**Manufacturing Production Engineering** modifying existing manufacturing processes or equipment
Marketing Engineering demonstrating feasibility, designing and improving the application or service	➧	**Advance Marketing Engineering** demonstrating the technical feasibility of new applications of existing products and applications of proposed products	**Application Engineering** designing applications whose technical feasibility has been proven for existing or proposed products	**Service Engineering** installing existing products and improving their application

proximating that of the doctoral degree, although there are many ways of doing this including just working on the job and learning as one works. For technical work entitled product production engineering, manufacturing production engineering, and installation and service engineering, the technical content of the undergraduate curriculum in mechanical engineering is probably more than is required and for people who work dominantly in this area it is possible to substitute some of the more subjective courses for some of the technical courses given in the normal curriculum.

From this vantage point, I hope I have made it clear that the product of the baccalaureate curriculum is reasonably adequate for today's work. About the only changes I can suggest are to spend more time on the body of principles and less time on the so-called industrial arts for the great majority of the students since this is about the only way that the educational institutions can remain abreast of technological acceleration.

E. T. W. Bailey

Combustion Engineer,
Steel Company of Canada,
Hamilton, Ont.

Products which win consistent demand through good and bad times must have qualities which satisfy the purchaser. The engineering graduate has been such a product. It seems reasonable to conclude that the curriculum which moulded his thinking was basically satisfactory.

For years the curriculum, which embodies specialization into civil chemical, electrical, mechanical, and other groups at the beginning of the second or third years, has been used by many Canadian universities. Well-meaning people have advocated earlier specialization and equally well-meaning people have held out for no specialization. The latter contend that a common course would best serve the profession.

Actually, a youth starts to specialize when he charts his course through high school. He takes another big step when he enrolls in a particular university or faculty. Entering second or third year, he again has had the opportunity to chart his training into the channels he likes and for which he feels he has an aptitude. This pattern can be compared to the sturdy tree which develops strongest branches when they leave the trunk at the earliest time.

W. Scott Hill, manager of engineering recruiting, writing in the September *General Electric Review*. says:

"Engineering colleges for the past 20 years have tended to turn out graduates equipped with the practical knowledge to begin work immediately in some specialized field. This seemingly meets the needs of many industries at the moment, but only a slight backward glance shows that many of the technologies of even a few years ago are already superseded.

"This realization led to a search for programs that would not be obsolete by the time the senior student took his degree in hand and accepted a job.

"Certain basic technical material underlies most technical work. From this search evolved a greater emphasis on these common understandings. They begin with physics and chemistry, build up to the engineering sciences, seek the true meaning and understanding of mathematics, and end with some concentrated study experience in one or more of the engineering fields.

"Most of the advanced colleges have revised their thinking: delay specialization until the individual reaches the very end of his undergraduate work; keep it relatively minor in character even then. The truly specialized knowledge will come later — either in graduate school or through some advanced education process associated with work experience."

This view might be carried still further and advocate that all faculties of a university have a common first, second, third or even fourth year curriculum.

Usually, in these matters, the most satisfactory solution is found somewhere in between the extremes. In general, the existing curricula used in Canada's leading universities meet the "somewhere in between" specification.

The common, or unspecialized, graduate might be more acceptable to industrial giants who already have built-in colleges in their organizations. But what about the thousands of small industries and consulting firms which cannot offer or afford such training facilities? On the one hand, we are repeatedly told that this is an age of specialization while, on the other hand, plausible reasons are being advanced for withholding specialized training from the curricula.

The basic technical material, physics, chemistry, and mathematics, with few exceptions, have not changed in the last twenty years. The technologies embodying the application of basic principles have, on the other hand, experienced phenomenal growth and changes. The methods of engineering approach, which employ the changing technologies, are fundamentally more constant. Nevertheless, engineering or applied science has within itself wide variations of approach so that specialization becomes mandatory. Earlier specialization offers a better opportunity for the student to grasp these special techniques under the guidance of an expert teacher once the basic subjects have been mastered.

The following simple questionnaire was submitted to engineers of the Steel Company of Canada, Limited. No arguments for or against various curricula were given.

"Mark ..... which of the following type of curriculum, leading to the bachelor degree in engineering, you consider is the better.

(a) Specialized curriculum, that is, chemical, civil, electrical, mechanical, metallurgical and mining.

(b) Common curriculum, for all the above, which might turn out a product which industry would accept and train in their own special fields."

The results showed 61 per cent favoured the specialized, while 39 per cent favoured the common curriculum; 134 answered the questionnaire. The result is an interesting spot check for one company.

Other Changes

The press recently told of other projected changes in the engineering curriculum. One aviation company, for example, plans to give training equivalent to a university engineering degree, confirmed with examinations by the Association of Professional Engineers of Ontario. Instructors will be company engineers who will have to leave their regular duties to teach classes about nine hours per week. How many years it will take the student worker to obtain the engineering degree equivalent, was not disclosed. It will indeed be difficult to bring the quality of this instruction, however well meant, up to that of seasoned professors. It would appear that the ultimate cost might be greater than if the company sent the student directly to college where he can also benefit from the many useful extra-curricular advantages.

The press has also featured headlines about our crowded universities and the urgent need for more engineering colleges. These projected colleges have strong advocates of the common curriculum, as it would reduce their costs.

The net time a student spends in an engineering college at present is six months. The rest of the year valuable physical teaching facilities lie idle.

In an 8,760-hour year, a steel company uses its major facilities 8,688 hours. Engineering colleges use their facilities approximately 1,144 hours to turn out a product. By installing some air-conditioning equipment, giving the staff extra help and raising their salaries, a summer semester could be established. This would require a fraction of the capital required to establish new colleges, complete with staffs and physical facilities. Such an arrangement would double the usefulness of existing facilities to 2,288 hours per year.

Further doubling the hours of use by inaugurating two shifts might achieve the maximum potential of 4,576 useful hours per year. It is not likely, however, that a night shift college course would be very popular. There might be reasonable hope for the success of a summer semester, especially if industry and others got behind it and offered jobs to these people during the winter months. Longer paid vacations for industrial workers are becoming more common and may have to be taken in winter, and the help of college people may become as useful in winter as it now is during the summer. It would be interesting to know if the Russians allow their engineering educational facilities to be used as few hours in the year as we do.

A modern engineering curriculum, whether specialized or common, should feature the possibilities of adventure in order to attract a greater number of students. Colleges would do well to make more use of idea stimulation techniques; creative thinking themes should be integrated with presentations of regular material or given separately. Applied imagination would give students a wonderful interest boost. More and more the engineer must do the broad, creative thinking and leave the details and repetitive work to others. The student would delight in the intellectual free-for-alls similar to those being conducted by some of the larger industrial concerns.

There are few experiences in life so satisfactory as getting good ideas. Quite often they burst into the mind, glowing with the heat and delight of creation. How they do is a complete mystery. We do, however, have methods for stimulating their birth and frequency, with which every student should become familiar.

Let us not take this subject of curriculum arrangement too seriously, for, after many hours of concentrated research, I found someone has solved the whole matter, as indicated in the Dartmouth College Song:

Eleazer Wheelock was a very pious man;
He went into the wilderness to teach the Indian,
With a Gadus ad Parnassum, a Bible and a drum,
And five hundred gallons of New England rum . . . .
Eleazer was the faculty, and the whole curriculum
Was five hundred gallons of New England rum.

Professor L. Stuart Lauchland

Head, Department of Engineering Science,
University of Western Ontario,
London, Ont.

The last member of an unrehearsed panel often finds himself in an unenviable position. I am no exception to the general rule. Last week I discovered that many of the things I intended to say this afternoon are going to be said in better words after dinner this evening by the president of this university. Not many minutes ago I mentally tore up my second set of notes while listening to the president of the Illinois Institute of Technology. The remarks I am going to make now are my third, and last, effort.

There will be general agreement in this room on most of the contents of the A.S.E.E. Committee Report on Engineering Education After the War (Hammond Report, 1944) and of the A.S.E.E. Committee Report on Evaluation of Engineering Education (Grinter Report, 1955). All of us will agree, I think, that our complex industrial world needs engineering specialists. Most of us will agree, I think, that an engineering education has been a satisfactory general education for many individuals who have gone on to successful and satisfying careers in non-engineering fields.

At this point we divide. Some of us believe in specialized undergraduate curricula. Some of us believe in more general undergraduate curricula. There are few neutrals.

I am a supporter of the more general programmes. However, I must admit that the existence of two schools of thought has made me re-examine my own philosophy of engineering education. I have come to the conclusion that the differences in the two kinds of undergraduate curricula are not as great, and may not be as important, as the differences in motivation, ability, enthusiasm, intelligence, and cultural background of our raw material — the graduates of the high schools.

Questions for Industry

The following remarks and questions are intended to promote discussion and pleasant argument. I am more interested in the reactions of the industrial representatives than in those of the university representatives.

(1) A student's time during his undergraduate course is so valuable that none of it should be spent in the acquisition of skills and knowledge that can be and should be gained in industry after graduation and in the acquisition of skills and knowledge that may soon become obsolete.

(2) The graduates of highly-specialized courses may not find the highly-specialized jobs for which they are "trained" and may not be suitable for alternative jobs.

(3) The knowledge and the attitudes with which a student leaves the university must last him for a lifetime in a world that is always changing. We are preparing students for about 40 years of professional life — 40 years of self-education and self-development — and all of these years are in the future.

(4) Has too much attention been paid to the demands that an engineer must be immediately useful on graduation? Most large firms have training programmes. Should the firm hiring its first engineer consider only one who has had some experience after graduation?

(5) The engineering schools will be doing a good job if their graduates (a) know the basic sciences, (b) know the engineering sciences, (c) have some knowledge of some of the humanities and the social sciences, (d) can communicate ideas in the oral, written, and graphical forms, (e) have studied some of the aspects of analysis and synthesis of engineering systems, with some emphasis on one broad field of engineering, and (f) can use a library.

(6) In addition to the undergraduate curriculum, there are other influences at work. The benefits of extra-curricular activities and of life-long friendships are more important than the presence or absence of certain subjects in the curriculum.

(7) The four-year course is satisfactory for the majority of students. Study at the graduate level will provide for any desired specialization.

(8) What can we in the engineering schools do to encourage and develop creative thinking? We must never forget that engineering is a creative profession and that the members and members-to-be of the profession must, while not forgetting the past and ignoring the present, look toward the future.

Engineering at Western

Professor Lauchland then outlined the development of engineering education at The University of Western Ontario. The Department of Engineering Science was established in 1954 to offer a two-year course designed to prepare students for admission with advanced standing to certain engineering courses at other Canadian universities. In 1956 the Board of Governors approved the expansion of the two-year course to a four-year course leading to a degree and started planning for the construction of an engineering science building. The planning is based on a first-year enrolment of 150 and a total undergraduate enrolment of about 475. The department will, in the course of time, become a separate school or faculty.

Subsequent Discussion

The moderator noted that many interesting points were raised during the discussion that followed the presentations by panel members.

These included: Is the graduate immediately useful? What should be the training program of the large firm? Since the university has the student for 28 months at most in four years, nothing in the way of skill or technique should be taught in college which could just as well be taught in industry. Should there be required summer reading? A discussion developed on lecturing (passive) *v.* tutorial (active) methods of teaching: the undergraduate is taught by lecture and by recitation (problem periods) while the graduate gets tutorial and seminar methods. The lecture (passive) system does have the one outstanding advantage in that it is possible to expose the student to great scholars.

DISCUSSION

of Technical Papers and Other Articles

THE KAPLAN TURBINE IN CANADA

G. Dugan Johnson, *S. Morgan Smith Company, York, Pa.*

The Engineering Journal, 1956, June, 769

Discussion of this paper by Messrs. Fintak, Kerr, Sproule, and Warnock (referred to below by the author) was published in the Feb., 1957, issue.

D. E. Brainard[1]

The Kaplan turbine has had a deep effect on the hydro industry in the past quarter century. None are more aware of this than the suppliers of generators for hydraulic turbine drive. Mr. Johnson's summary of history and attainment over that period is most interesting. His remarks on future trends require some comments.

As generally recognized in the hydro industry, mechanical design of the rotor is the most important single limit to the permissible size of generator at a given rated speed. As the specified overspeed increases, this factor becomes more restrictive. In this day of large units, there will be increasing pressure on purchasers to specify something less than the "off-cam" overspeed.

There has been a tendency to consider that the design overspeed is a nominal condition but that no serious harm would result if the rotor attained an overspeed such as to give calculated stresses up to or even exceeding the yield point. The author describes this as "present practice." The position of purchasers and generator suppliers alike has been and, I believe, should be that the generator must never be expected to exceed the specified overspeed. The "factor of safety" represented by limiting calculated stresses at that overspeed to two-thirds of the yield point is generally required by purchasers to allow for differences between calculated and actual stresses. Only if the turbine builder can develop design features that will limit the overspeed and can demonstrate their validity, may the purchaser be justified in specifying the resulting reduced value for generator design.

In the matter of thrust bearing design, the industry has cause for real pride. The ten Bonneville bearings, each carrying 3,000,000 pounds, represented a 50 per cent increase in load carried. Another increase, this time of 33 per cent, brought the load per bearing to 4,000,000 pounds at McNary. It may be added that the twelve domestic bearings in this plant have gone into service without a single failure.

The most difficult duty on a thrust bearing occurs at starting and unit pressures have hitherto been governed by this fact. The use of high pressure oil at starting is effective in removing this limitation, and thrust bearings for loads of 6,000,000 lb. to 7,000,000 lb. appear entirelv feasible. We believe, therefore, that rotor design rather than thrust bearing capacity is most likely to limit the increase in size of units.

Norman R. Gibson[2] M.E.I.C.

I would like to ask Mr. Johnson two questions.

(1) If general practice is to accept results of model tests as a basis of contract, what assurance can be given that the prototype will be manufactured in exact proportion to the model?

(2) Is the author able to state that there is a tendency toward lower efficiency as the specific speed of Kaplan turbines is increased?

H. R. Sills[3] M.E.I.C.

Mr. Johnson in his paper hints at problems in connection with the design of generators attached to Kaplan turbines. I may say they are substantial. The worst problem is concerned with the offcam overspeed which appears to be a hypothetical rather than an actual hazard. For usual generator proportions the maximum generator capacity is limited directly as the 3/2 power of the permissible rim stress and inversely as the r.p.m. and the cube of the overspeed ratio.

For the type of construction ordinarily used for generators connected to Kaplan turbines the maximum permissible size can be approximated from the following formula:

$$\text{Max. kva.} = \frac{K \times 3 \times 10^5 \times S^{3/2}}{\text{r.p.m.} \times (OS)^3}$$

where K = output constant (from 8 to 11 x 10^{-5} depending on reactance and power factor)
S = maximum permissible rim stress in lb/sq. in.
r.p.m. = rated speed
OS = over speed ratio = runaway speed/rated speed

The Kaplan turbine with both high speeds and higher overspeed ratios has an exponential advantage on the only recourse available to the generator designer, rim materials of higher strength.

The rim stress the generator designer must contend with varies as the 2/3 power of the r.p.m. and the square of the overspeed ratio. A reduction of even 10 per cent in the overspeed ratio would reduce the rim stresses 21 per cent for the same kva. or permit a 33 per cent larger machine for the same stress. This, I suggest, is a prime incentive to find ways of limiting these overspeeds.

With the off-cam overspeed largelv a theoretical condition, as the author suggests, it would appear that substantial advantage would accrue to all concerned if permissible rim stresses at this speed were accepted as 95 per cent of proportional limit rather than the present conventional limit of 66 per cent. Such a practice would permit the design of machines 1.73 times larger than the present practice permits or a less expensive machine (if capacity is not a limit), and yet provide normal factor of safety at proven overspeeds. This is by

[1]General Electric Company, Schenectady, N.Y.
[2]Consulting engineer, Niagara Falls, N.Y.
[3]Canadian General Electric Company, Limited, Apparatus Department, Peterborough, Ont.

no means as outrageous as it may sound. Maximum stresses may be accurately calculated, there always exists a margin of the actual proportional limit above the minimum specified for the material and no appreciable strain occurs until the yield point is reached, usually 10 to 15 per cent higher than the proportional limit. Even here the rim does not burst but stretches like an overstressed chain which will cause the poles to rub against the stator, braking the rotor to a slower speed. The stators are designed and anchored to withstand maximum short circuit stresses and it is reasonable to assume that the braking effort will not reach this value before speed has reduced enough to limit the stress. This condition is not much different from recognized practice in steam turbines where a runaway usually terminates due to the blades coming off and choking the casing.

Thrusts are also a problem. Presumably they will increase as the size of turbines increases. As yet there does not seem to be a limit to size of thrust bearings but shipping limits may cause problems with the supporting structure. I suspect this limit will apply equally to the turbine head-cover. If the upward pressure on the head-cover always coincides with the downward hydraulic pressure on the thrust bearing some mutual advantage may be gained by connecting columns between the hubs of the head-cover and thrust bracket. I tend to agree with the author that American and Canadian preference in respect to accessibility of parts will prevent European practice of mounting the thrust bearing on the head cover from becoming popular on this continent. Present machine designs permit as close coupling of the turbine and generator as the scroll case passages will permit.

I would that the turbine designers could do something about removing the oil head from the top of the generators. After years of endeavour the generator designers have managed to design oil tight bearings and so keep oil out of their windings and thereby reduce the worst fire hazard; and now come these oil heads! With the greatest respect for their efficient functioning I do wish they were put below where there is no possibility of an electrical fault.

If essential we would accept the compensating mechanism but we would prefer a tape, that could be decently buried, to the present crank rod. Most generator manufacturers have developed means to expedite the maintenance of their machines by methods for quick removal of top covers and other components. The oil heads and compensating mechanism, to put it bluntly, foul this up. Moreover after years of endeavour decently to enclose piping and the other intestines of the generators and give them sex appeal I have a very jaundiced view of the plumbing that the turbine designers drape over the side and top of the generators to their oil head.

E. B. Strowger[4]

The author has stated that the Kaplan turbine is especially well suited to run-of-river developments with wide variations of flow and head and little or no storage. This is an important consideration and may be shown by means of duration curves like those of Figure 1. These curves show the flow, power and length of time of daily peak operation in duration form for a hydro-electric project on a river having an average flow of about 2500 c.f.s., the head at the site being 76 feet and the usable pondage small. The flow varies from a maximum corresponding to the 100 year flood value estimated at 30,000 c.f.s. to a minimum of 1100 c.f.s. From the most economic installation, a one-unit plant with a relatively high discharging capacity is indicated. The c.f.s. capacity contemplated for a one unit Francis installation is shown by line A and that of a one unit Kaplan installation of comparable size by line B. (Fig. 1 is on page 299.)

The utility system to utilize the project requires 8-hour operation of this plant except during the flood season when operating time of the station increases to 24 hours per day. The figure shows the following advantages of a Kaplan installation.

(1) Greater annual energy generation due to the large overload capacity of the Kaplan turbine. This is shown by the cross hatched areas.

(2) Higher capacity available in the low flow season due to the higher part gate efficiency of the Kaplan.

(3) Based on what is considered to be the dependable December flow, a larger firm capacity supplied to the system.

(4) Smaller drop-off in capacity than in the case of a Francis installation when, in the flood season, the head is low.

The value of the additional peak capacity may be as great or even greater to the utility system than that of the additional annual generation of kwh. For instance, on a 20,000 kw. installation with a 50 per cent annual capacity factor a gain of 5 per cent in dependable peak capacity is approximately equivalent in value to a gain of 10 per cent in annual energy generation when evaluated by $25.00 per kw. of peak and 3 mills per kwh. of energy, these values representing the cost of equivalent steam power in the area. This may be shown as follows:

Value of 10 per cent energy gain·
8760 x 0.50 x 0.10 x 20,000 x 0.003
=$26,000.

Value of 5 per cent gain in peak
20,000 x 0.05 x 25
=$25,000

If, instead of the very limited pondage available as shown by Figure 1, the pondage is adequate for operation at the daily capacity factor required under the conditions defining dependable capacity, then it might be advantageous to install a fixed blade propeller turbine and operate it every day at the point of maximum efficiency, reducing the time on peak as the river flow reduces. Regulating capacity would, of course, be sacrificed with this type of operation.

Of course, the setting of the Kaplan turbine must be low enough to be sure the cavitation limit is beyond the 4,000 c.f.s. capacity shown by line B on the chart and the additional capacity required for the Kaplan generator will increase its cost and will offset to some extent the advantage of its higher speed. However, all factors considered, economic studies show many sites, with the characteristics of the one described, to be favourable to a Kaplan installation.

R. A. Sutherland[5]

Mr. Johnson's paper is a very useful compendium of advantages of the Kaplan turbine. Inasmuch as "the object of this paper is to encourage increased use of the Kaplan adjustable blade propeller turbine," it is to be regretted that Mr. Johnson had not given more definite information relating to the cost in money, materials or work which is required to obtain the benefits of the Kaplan turbine. The writer has several times had occasion to evaluate the merits of us-

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[4]Chief Hydraulic Engineer, Niagara Mohawk Power Corporation, Buffalo, N.Y.

[5]Hydraulic Engineer, Ebasco Services, Inc., New York, N.Y.

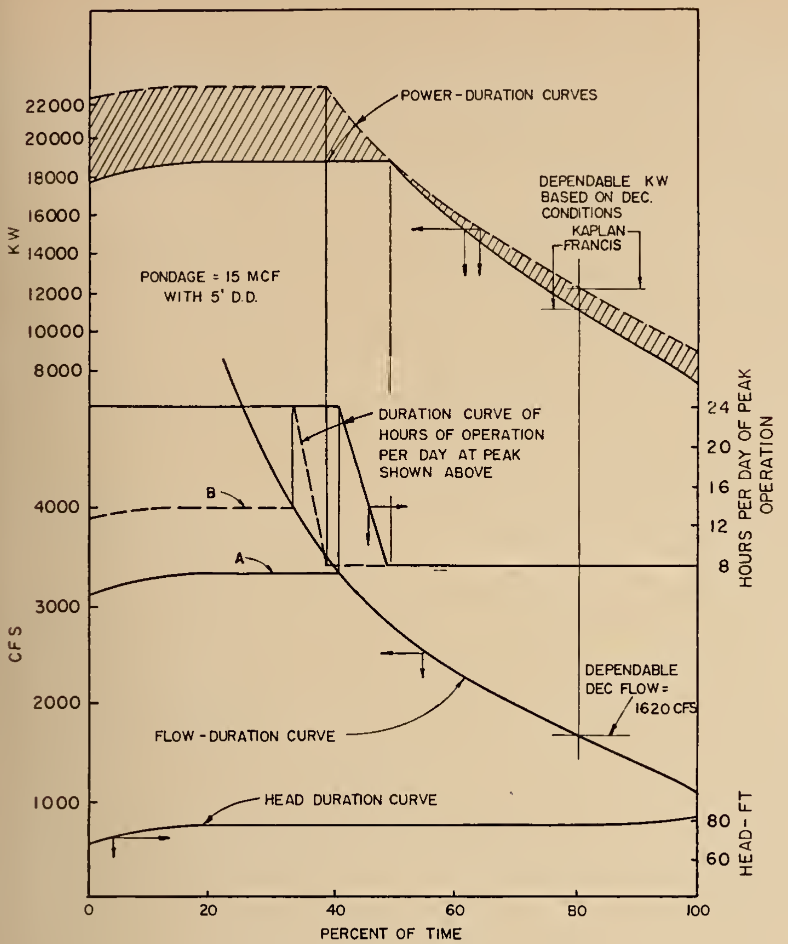


FIG. I
DURATION CURVES OF RUN OF RIVER PROJECT
--- KAPLAN
—— FRANCIS

ing one or more Kaplan turbines for a given installation, and has found all the features are susceptible of being evaluated. Some of these features are as follows:

(1) *Cost of Turbine* — In the writer's experience, a Kaplan turbine costs from 20 to 50 per cent more than a fixed blade propeller turbine of equal capacity.

(2) *Cost of Generator* — Some additional cost will ordinarily be applicable to the generator due to higher overspeed, provision of oil head, and other details of a special nature.

(3) *Setting of Turbine* — The Kaplan turbine may require to be set at a lower elevation which will usually entail additional costs in the powerhouse excavation, structure and other features.

(4) *Operating Advantages* — With a given known or assumed method of operation, it is possible to compute for the Kaplan turbine and the alternative turbines, the net results over a period of time and to evaluate the greater output of energy and the increased capability, particularly at times of high tailwater.

Each case must obviously be treated on its own merits, and the fact that the Kaplan turbine is not necessarily always the ideal unit is shown by the choice in some cases of Francis or fixed blade units as a result of a comprehensive study such as outlined. More generally, however, it is true that the use of at least one Kaplan in a plant with a head up to or perhaps over 100 feet is distinctly advantageous. The capacity to carry additional load beyond the rating is a feature particularly relished by operating engineers who come to depend on a Kaplan unit to tide them over their most severe peaks.

T. Zowski[6]

The author's paper reviews in a concise manner the basic characteristics, design developments, and application of Kaplan turbines. The writer would like to offer a few comments based on his company's association with the design of a number of interesting Kaplan unit installations which include the first Kaplan turbine installation in America, the first high head (105 feet) installation in the Western Hemisphere located on the Rio Negro in Uruguay, and several other plants in which new turbine features were introduced.

Bids are being taken in Canada for a Kaplan turbine rated 30,300 h.p. under a net head of 112 feet, for the Centre Falls plant of the Great Lakes Power Company, Limited. The rated head of 112 feet is, to the best of the writer's knowledge, the highest rated head specified to date for Kaplan turbines in Canada and the United States.

In discussing protection against cavitation, the author mentions the use of solid cast stainless steel blades on small runners and includes the 110-inch runners at Lower Great Brook in Nova Scotia as an example. It may be of interest to mention that solid cast stainless steel Kaplan runners of nearly twice this size (208-inch) have been in operation for about one year now at the Box Canyon Plant in the United States, with outstanding performance results, especially in the overload range. Under the rated head of 41 feet, the turbines operate satisfactorily with loads 17 per cent in excess of the corresponding guaranteed cavitation limit, and about 7 per cent beyond the cavitation limit indicated by the model tests, without any evidence of pitting damage. This overload is appreciably greater than has been found practical on most Kaplan runners protected against pitting in the usual manner by prewelded stainless steel coatings. The Box Canyon turbine contract specified blades of carbon cast steel with welded stainless coatings, but in view of the large amount of costly welding work required on the blades, the turbine manufacturer found that the relative cost of solid cast chromium stainless steel blades would not be much greater, and actually furnished them at no additional cost to the purchaser.

Cast stainless steel blade inserts welded to portions of the blades were used on nine 110-inch Kaplan units at the Petenwell and Castle Rock plants designed by the writer's company for the Wisconsin River Power Company. These units have given good service, although under sustained overload operation the un-

[6]Chief Mechanical Engineer, Harza Engineering Company, Chicago, Ill.

protected blade surfaces along the inserts eventually suffered cavitation damage requiring welding repairs. Our experience indicates that solid cast stainless steel blades are far superior and should be given serious consideration for all future Kaplan installations except low head units.

Hydro plant operating experience indicates that it is economically feasible to operate Kaplan turbines for substantial periods of time with loads somewhat greater than the actual cavitation limit. The practical limit of loading is largely a matter of economics involving the value of the additional output and the cost of pitting repairs and associated outages, as well as a matter of acceptable vibration limits, but the writer believes it is generally feasible to exceed the cavitation limits by about 5 to 7 per cent. The author's views on this would be of interest.

The use of concrete semi-spiral cases for heads up to 100 feet is mentioned by the author. The experience of the writer's company in the design of concrete spiral and semi-spiral cases indicates that the considerable structural design problems, complicated construction work, and difficulties in maintaining watertightness tend to make the use of concrete spiral cases questionable for heads greater than about 80 feet, except for extremely large turbines. In our design of the Scott Falls plant in Ontario for the Great Lakes Power Company, Limited, it was found less costly to use plate steel spiral cases for the two 104-inch, 10,000 h.p. Kaplan turbines which operate under a maximum head of 75 feet.

The Author

The author is extremely grateful for the large number and high quality of the discussions, which supplement the information given in the paper and add greatly to its value. This is particularly true of those by Messrs. Sills and Brainard, who represent generator manufacturers, as well as those of Messrs. Strowger, Sutherland and Zowski, who represent designers and/or owners of hydro plants. The general agreement from the other turbine manufacturers' representatives, Messrs. Fintak, Sproule, and Warnock, is significant, and the questions raised by Dr. Gibson and Mr. Kerr are certainly worthy of serious consideration. Although time does not permit a detailed examination of each point raised by these gentlemen, the author is indeed thankful that their discussions are hereby available in printed form to "complete" the presentation of the original paper.

Mr. Sutherland has emphasized the need for a careful evaluation of the various economic factors involved for each specific installation, and Mr. Strowger has presented an actual example of the operating advantage of a Kaplan turbine. In addition to the increased annual energy output, Mr. Strowger has clearly indicated the practical value of the additional dependable peak capacity attainable with the Kaplan.

Mr. Zowski has pointed out that the "extra" capacity of the Kaplan turbine is even greater than that calculated from the model tests in the laboratory, since it is possible to operate at loads greater than the cavitation limits indicated by the model. Actually, experience has shown that 5 to 7 per cent additional capacity can be obtained from a large prototype unit without loss of efficiency due to cavitation and substantial additional capacity can usually be realized before objectionable vibration or excessive cavitation pitting is experienced. It is interesting to note that it is economically feasible to cast fairly large Kaplan blades entirely of stainless steel in order to take advantage of this additional capacity with minimum cavitation pitting.

DISCUSSION

The Editor invites discussion of technical papers and other articles in *The Engineering Journal.*

Messrs. Sills and Brainard both state that maximum generator capacities are limited by mechanical design of the rotors, rather than by permissible thrust bearing loads. Mr. Sills agrees with the author's statement that "present practice *seems* to indicate acceptance of the idea that the generator must never be expected to exceed the specified overspeed," which can be limited by dependable automatic design features as mentioned by the author.

Mr. Sills' objection to the Kaplan oil head with attached plumbing and compensating mechanism dangling therefrom is certainly understandable. Possibly what he has in mind is an arrangement similar to that shown in figure 1-7 of reference no. 11 with an oil transfer unit around the turbine shaft, but with the blade servo-motor and generator thrust bearing located as in arrangements 1, 2 or 3 of that figure. Although not yet popular in Canada or the United States, such oil transfer units are feasible and have been successfully used by the author's company for controllable-pitch ship propeller applications.

Mr. Fintak's account of his company's early experience with manually adjustable runner blades is interesting, but was not mentioned in the paper because a "true" Kaplan has blades that can be automatically adjusted during operation. The author agrees with Mr. Sproule that a fixed-blade propeller turbine would be more economical and more efficient than a Kaplan for an installation with essentially constant head and discharge conditions. Mr. Warnock's comments, especially those referring to his company's experience with high-head Kaplan and diagonal-flow turbines, are extremely interesting and worthwhile additions to the author's paper.

The answer to Dr. Gibson's second question is that no "tendency toward lower efficiency as the specific speed of Kaplan turbines is increased" has been observed by the author's company to date, except when the increase has been obtained merely by increasing the inclination of an existing blade design to increase the unit capacity. The moderate loss in efficiency as the blade inclination is increased beyond the best efficiency point is shown by the McNary "index" test curves on Fig. 3 of the paper. However, when the specific speed is increased by designing for the actual conditions of a particular installation, the efficiency could be approximately the same at the higher specific speed. As mentioned in the paper, draft tube design is also intimately associated with Kaplan turbine efficiencies.

The answer to Dr. Gibson's first question is that the laboratory model and the prototype units are manufactured from geometrically proportioned (homologous) drawings within reasonably exact tolerances. Templates are used for the critical turbine components, such as runner blades and wicket gates, and the water passages to and from the turbines are easily constructed so nearly homologous that any differences in flow patterns and hydraulic losses are negligible, except for the

(Continued on page 304)

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

CONSTRICTED TUNGSTEN-ARC CUTTING OF ALUMINUM

Ayler, O'Brien, and Maier — *Welding Journal*, 1956, Dec.

An argon-hydrogen gas shield is being used with a constricted tungsten-arc for the cutting of aluminum, magnesium and copper. Although the mechanical metal cutting methods of shearing or sawing produce high quality severance edges, often their use is limited and it becomes necessary to resort to drilling or chipping. The tungsten-arc has proven to be a much faster means of cutting than any of the mechanical methods and at the same time it provides high quality kerf walls. With a manual cutting torch, aluminum plate ¼ in. thick can be cut at 60 i.p.m. and 1½ in. at 15 i.p.m. A machine operated torch permits these speeds to be increased to 100 and 35 i.p.m. respectively. Greater speeds can be obtained when cutting magnesium, due to its lower thermal conductivity, and conversely the rates are less for copper.

Tungsten-arc cutting employs a constricted arc between a tungsten electrode and the workpiece, in conjunction with a high velocity gas stream. The arc is concentrated and localized upon a small area so that the intense heat melts the metal. The gas which is preheated by the arc expands greatly and is forced through the constricted orifice. Molten metal is then continuously removed to form a kerf by the jet action of the gas stream. The cutting gas also protects the kerf walls from oxidation and a high quality saw-like cut free of dross is obtained.

The depth of the heat-affected zone is approximately the same for ¼ to 1½ in. thick plates providing that maximum cutting speeds are used for a given power input. Hardness readings indicate that the approximate normal hardness of the plate is reached beyond a depth of 0.064 inch. Welds subjected to tensile, guided bend, and free-bend tests showed that arc-cut edges are equivalent to saw-cut edges.

Tungsten electrodes similar to those used for inert gas tungsten-arc welding are used in the cutting torch and electrodes of ⅛ in. dia. cover the complete range of aluminum thickness up to 1½ in. The rate of electrode consumption is very low. High operating voltages are needed; 400 amp. at 70 to 85 arc volts. Motor-generators with a rated capacity of 600 amp. and an open-circuit voltage of 100 volts have proved satisfactory. Water cooling of the torch nozzle is necessary to prolong its life.

Two different mixtures of argon and hydrogen are used with this process: 65 per cent argon and 35 per cent hydrogen for machine operated torches; 80 per cent argon and 20 per cent hydrogen for manual cutting. The lower hydrogen content for manual cutting provides the operator with a greater latitude of arc length. For best results this should be ¼ in. If the hydrogen content is greater than 20 per cent the arc is extinguished should the nozzle-to-work distance exceed ¾ in. Argon is used in these gas mixtures because it is inert and an arc can be readily established in an argon atmosphere. Hydrogen is used because it yields a high arc voltage due to its high resistance, producing greater heat at a given current.

ENERGY FROM THE SEA

Water Power, 1956, Nov. and Dec.

These articles contain a description of the design and construction problems which are being solved in order to harness tidal energy near the French seaport of St. Malo. The project, which is to be in full commission by 1960, involves the erection of a tidal dam across the north of the River Rance where it enters the sea, and depends upon a combination of tidal power generation and pumping operations.

The dam will be 2329 ft. long and 157 ft. wide with the height of the crest above the highest tide level 4.92 ft. and the enclosed surface about 7¾ sq. miles at high tide. Both generation and pumping are to be accomplished by 38 totally submerged upstream bulb type turbine units each of 9000 kw. capacity, immersed in orifices in the dam with their centre line 18 ft. below low water level. Controls and switch gear are accommodated in the hollow upper part of the dam while the top serves as a bridge across the river. The dam will also contain a number of sluices and on the west bank locks are to be provided for river navigation.

Extensive studies involving much detailed calculation and model testing were used to prove the scheme to be practicable. It proposes to generate power both during the filling and emptying of the estuary over a greater and more flexible time period than that of the normal tide ebb and flow. It utilizes energy from the national electrical supply network at off-peak periods to provide an artificially greater head by pumping water into the basin at high tide or out of the basin at low tide. This requires a water turbine which will operate efficiently both as a pump and a turbine under variable head and with water flow in either direction.

Such a machine has been developed by the French engineers after years of research and experiment. It is of the monobloc type with the following characteristics: speed 88.2 r.p.m., maximum operating head 11 metres, maximum pumping head 6 m., nominal rating 9000 kw. with direct or reverse water flow for variable head between 11 and 5.5 m. with flows between 100 and 270 cu. m. per sec.

The difference of level between high and low tides for this region is about 44 ft. at exceptional tidal periods and the tidal range is 36 ft. at spring tides, 29 ft. at average tides and 18 ft. at ebb tides. The cycle of operation is as follows. If high tide exists on both sides of the dam and if energy can be borrowed from the electrical supply system for pumping purposes (presuming an off-peak period exists) it is possible to raise the level within the estuary; as the tide falls away outside the dam a head becomes available which is greater at any given state of the tide than would have been the case without pumping. Generation starts as soon as the minimum head is reached and this occurs earlier in relation to the tide movement because of pumping.

Generation continues until the head is reduced to the minimum level, at which time the turbine blades are feathered and the units act as valves, each turbine passing 180 cu. m. per sec. under a head of 1m. as compared to the main sluice valves each of which permits a flow of 420 cu. m. per sec. under the same conditions. By converting the 38 turbines into straight - through valves and opening all sluices the water within the basin can be rapidly evacuated near the time of low tide by gravity means. Since the machines are totally submerged, further water can be pumped out if electrical energy is available. As the tide rises on the outside of the dam a generating head is reached earlier than would have been the case if the water level had not been artificially lowered. As the tide continues to rise generation will take place until sufficient water has entered the estuary to destroy the minimum generating head. Rapid opening of all turbine passages and sluices then permits high tide level to be reached within the basin and the cycle can restart.

A most important feature of the cycle is that it can be greatly varied by means of pumping during off-peak hours so that tidal power can always be made available to the electrical distribution network when most needed. Full details of the cycle studies are given. The total capacity of the plant will be 342 Mw. with the annual output of energy exceeding 800 million kwh. over and above that borrowed for pumping purposes. The estimated cost of the project is about 95 million dollars.

This development is considered to be a pilot scheme for other large tidal-power proposals. One under study is a possible enclosure of the Baie du Saint Mont Michel adjacent to St. Malo. This dam would be 23.4 miles long enclosing a basin of 270 to 300 sq. miles and would contain 1200 generating units with a total estimated capacity of 8 to 10 million kw. giving an annual supply of electrical energy about half that presently used in France. If carried out it is expected to take 15 years to complete.

It is pointed out that this method of harnessing tidal energy would be well suited to work in conjunction with atomic power plants. Such plants are restricted to continuous operation to avoid poisoning by xenon 135 which is caused by shut-down. It is foreseen that nuclear power could reach such a proportion of the total power developed that the shutting down at nights of all thermal and water-power stations would still not load the nuclear plants sufficiently. Instead of dissipating the energy or selling at a loss it could be usefully diverted to pumping operations in tidal power plants.

METAL FORMING WITH EXPLOSIVES

American Machinist, 1957, January

Several aircraft companies are working with explosive manufacturers in experimental investigations of metal forming using explosive charges as a source of pressure. Previously, cartridge-actuated devices have been employed for many purposes such as firing rescue lines, fishing lines, pilots on ejection seats, parachutes, etc.; and to tack rugs, drive studs into steel or concrete, start jet engines, or cut cables. However, present experiments indicate that cartridges may be used to punch holes in high strength alloys, to flare and bulge tubing, to form "non-formable" alloys of stainless steel, to avoid spring-back in forming titanium alloys; as well as to swage, upset, and cup shapes and materials for which no other process has been successful.

Limited research has shown that most metals react differently under an impulsive loading compared to the conventional loading that occurs under a hydraulic press or a drop hammer. The energy of explosion is absorbed partly, or often completely, by the metal being formed so that work hardening characteristics are changed and grain structure may be altered. The velocity at which the load is applied has important effects. Each alloy has its own critical velocity. Too fast a shock wave may shatter it to fragments while a reduction of a few hundred feet per second will give good plastic flow. Elongation far beyond that possible by conventional methods has been obtained. There are two types of explosives employed: low explosives are powders such as those used in ammunition which burn rather than explode; and high explosives are those which decompose rather than burn, some developing shock wave velocity well over 4 miles per second.

This method has also been successfully applied to the punching of clean holes in sheet steel of 250,000 p.s.i. tensile strength without cracking the surrounding metal and without dimpling if a die is used.

THYRATRONS CONTROL DIE-CUTTING MACHINE

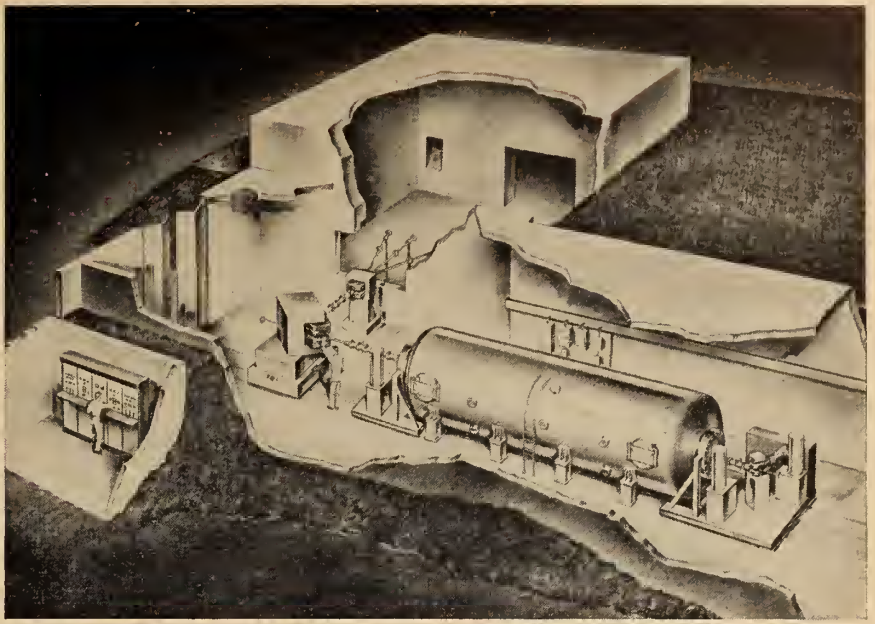
R. W. Bradley, *Electronics,* 1957, January

Adaptation of electronic control to a swinging-beam die-cutting machine used for cutting leather, plastic, light sheet metal or metallic cloth has resulted in more efficient operation with greater operator safety. Machines which utilize only a mechanical linkage system with a fixed stroke from a flywheel crank, produce high impact forces with consequent high stress and vibration, and also require that die sets be of the same height to prevent die sticking or incomplete cutting.

The new machine has an electronically controlled cutter stroke which limits the force developed to that required for the particular cutting operation. This is accomplished by means of a hydraulic pressure system actuating the cutting head. Sharp fluid cut-off is provided by a solenoid-operated valve in a closure period of approximately 10 milliseconds. The cutting stroke is terminated electronically when the cutting die completes the electrical circuit between the beam striking plate and the conductive cutting surface plate. The striking plate is attached to the bottom of the beam but electrically insulated from it, and the rest of the machine including the cutting surface plate is at ground potential. With this arrangement the beam height position is relatively unimportant and dies of different heights can be used in sequence without machine adjustment. Elimination of die sticking and die damage, a longer life of cutting surface, improved cutting performance, and reduced operator fatigue are claimed.

The control stops the beam travel in a manner to give regulated die penetration into the conductive cutting surface ensuring accurate cutting with a minimum expenditure of energy. It also includes an accurately repetitive time delay giving deeper cutting surface plate penetration to permit the pressure build-up necessary for cutting soft fibrous materials such as metallic cloth.

An important safety feature is the use of the hand to hand electrical resistance of the operator's body as a triggering device to stop the beam travel and prevent injury if one hand should contact the striking plate while the other holds the bare metal handle of the machine actuating switch. The electronic assembly is carried on a shock mounted printed circuit board. Thyratron tubes are used instead of the vacuum type because of their longer life, sturdier construction, greater grid-cathode distance, and satisfactory operation at reduced heater voltage. A control circuit schematic is presented and the operation described.



TANDEM ACCELERATOR FOR CHALK RIVER

An artist's conception of the 10-million volt "tandem accelerator" which is to be installed at the Chalk River project of Atomic Energy of Canada Limited early in 1958. The machine, which is being designed and built by High Voltage Engineering Corporation, Burlington, Mass., will be the world's highest energy accelerator working on the Van de Graaf principle. Chalk River at present has a three million volt Van de Graaf accelerator; this is used to bombard materials with a beam of particles to determine the structure of the nuclei of certain light elements. The new machine, which consists of two specially designed Van de Graaf accelerators coupled together and housed horizontally in a tank, will considerably extend the field of measurements possible both for light nuclei and for a large number of heavy elements.

SMALL TELEVISION CAMERA

French Economic and Technical Bulletin, 1956, no. 9-10

The Compagnie Generale de T.S.F. has developed a miniature television camera which is portable and fully independent of external power sources. The whole equipment weighs only 17 pounds, including the camera (2.8 lb.) and two cases containing batteries and other equipment (about 14 lb.).

The range of the unit depends on topography, but under favourable conditions, especially from an aircraft, perfect results are obtainable over 20 to 30 miles.

Industrial and military, as well as commercial, applications are being studied. The camera was used by CBS during their television coverage of the 1956 political conventions in the United States.

RECENT DEVELOPMENT LOANS BY THE WORLD BANK

Chile, Nicaragua, Australia, Japan, and India are among recent recipients of loans from the International Bank for Reconstruction and Development, perhaps better known as the World Bank.

Chile has received $15 million for electric power development during 1956-62. This will provide some 166,000 kw. of an overall program for 400,000 kw. of additional generating capacity, mostly hydro-electric. This is the second such loan.

A loan of $1.6 million to Nicaragua will supplement an earlier loan of $7.1 million towards constructing a 30,000 kw. thermal power plant and extension of the distribution system in Managua. The first 15,000 kw. unit should be ready for commercial operation in March 1958.

The Commonwealth of Australia has borrowed $27 million, of which $9,230,000 from the World Bank, towards buying (in dollars) Boeing and Lockheed aircraft and parts for Qantas Empire Airways Ltd., the international airline owned by the Commonwealth Government.

Two loans were made to Japan. The first, equivalent to $4.3 million, will largely be used to import equipment which will be used on pilot projects to test the feasibility of land reclamation in Japan by modern mechanical methods. The second loan will finance part of the cost of constructing a modern strip mill at the Kawasaki Steel Corporation's plant near Tokyo; when the new mill is in operation, now scheduled for 1959, Kawasaki will be one of the most modern and efficient steel producers in Japan.

The loan of $20 million to India is also for the expansion of the steel industry. It will help to finance additional rolling capacity for The Indian Iron and Steel Company Ltd. (IISCO), a privately owned company which is the second largest steel producer in India. Output of semi-finished and finished steel will be raised to 800,000 tons annually by the added rolling capacity.

ABSTRACTS OF PAPERS PRESENTED TO THE ENGINEERING INSTITUTIONS IN BRITAIN

As mentioned in the February issue of The Engineering Journal (p. 159) it is proposed to publish abstracts of some of the papers presented to the British Institutions of Civil, Electrical, and Mechanical Engineers.

Institution of Civil Engineers

The analysis of prestressed concrete structures and the application of recent research. P. B. Morice.

Structural and Building Paper No. 51

The paper illustrates the application of some results of recent research on the behaviour of prestressed concrete structures. A simple set of expressions is developed for the elastic design and ultimate load-carrying capacity of prestressed members in both statically determinate and indeterminate structures. The use of these expressions in the analysis of continuous beams, portal frames, and bridge decks is discussed in the light of the results of experimental work. Some aspects of research on the effects of friction between prestressing tendons and their ducts in post-tensioned members are included, together with the principal results of a study of the transmission length in factory-made pretensioned units.

The design and construction of a laboratory for research in underwater ballistics. C. L. Champion, R. J. R. Hancock, M.B.E., and M. Woolfson.

Works Construction Paper No. 34

The paper describes research facilities recently completed for the Admiralty. These consist of a rotating arm for propelling models round an annular tank and a cavitation tunnel. Various problems arising in the design and construction of this very unusual plant and the associated civil engineering works are considered.

Institution of Electrical Engineers

Mechanical strength of power transformers in service. E. T. Norris. (No. 3244)

The mechanical stresses in power transformers have steadily increased with transformer size and supply system capacity. Short-circuit currents are generally based on the rupturing capacity of circuit breakers which has increased in 25 years from 1500 Mva. to 25,000 Mva.

The position has been accentuated by the established practice of auto-reclosing which makes repeated switching on to possible faults a normal practice, and the introduction of fault throwing for inter-tripping purposes where dead short-circuits are deliberately created under normally controlled conditions.

Using only simple mathematics, it is shown that the mechanical strength of a transformer is not a simple single value as is implied in the short-circuit clauses of standard transformer specifications. Some of the strains are progressive and some of the stresses cumulative leading to short term and long term characteristics. The resulting categories of mechanical strength are defined as initial, critical, and ultimate, the last named being usually the crucial one in service.

It is shown how the performance in service can be predetermined and the expectation of life, in terms of number of short-circuits, predicted for any given operating conditions.

Service records of failures on short-circuit are analysed and found to support the predicted values.

Methods of improving the expectation of life are considered.

A deep electrolytic tank for the solution of two and three dimensional field problems in engineering. E. R. Hartill, J. G. McQueen, and P. N. Robson. (No. 3131)

The electrolytic tank is playing an increasing part in electrical engineering design departments, particularly for the analogous solution of two dimensional field problems. The paper describes the design, construction, and operation of a general purpose deep tank for solving both two and three dimensional problems. Details are also given of the precision electronic potential and gradient measuring equipment, together with an assessment of the accuracy achieved and the precautions required.

The use of the tank is illustrated by typical applications which have been studied by the computation group within a large electrical engineering organization.

DISCUSSION — The Kaplan Turbine in Canada

(Continued from page 300)

universally-accepted increase in prototype efficiency because of the relatively smaller skin friction loss as the turbine size increases.

Apparently, Mr. Kerr questions the author's statement that "*current* practice is to specify accurately conducted laboratory tests on homologous models . . . and the contract guarantees are based on model performance." Actually, this procedure has been followed for all of the large Kaplan installations in the United States (except Safe Harbor) and the author's statement is not a personal opinion but an observed fact. The balance of the section on "Contract Model Tests and Field Tests" also consists of observed facts rather than personal opinions, except for the poor choice of the word "actual", as pointed out by Mr. Kerr, which could be replaced by the word "estimated" or left out entirely, without changing the sense of the statement. Actually, since the efficiency guarantees have previously been satisfied by the model tests, it is not significant whether the Moody or the Ackeret step-up formula, or something in between, or even no efficiency step-up at all, is used in connection with the field "index" tests to draw the prototype performance curves. The important point is that it is not economically feasible to measure the large water flow rates with sufficient accuracy to base the contract guarantees on a so-called "absolute" acceptance test so that recourse to "index" tests (in accordance with the ASME Test Code) is the only practical procedure.

The author wishes to thank all of the discussers for their valuable contributions, which have added greatly to the satisfaction of presenting a paper on a subject of current interest in Canada. He also wishes to thank the officers and members of the Engineering Institute of Canada for the opportunity to present the paper and for their courtesy and friendship extended to him at the Montreal meeting.

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

Severe cold weather slowed down construction work considerably during January. There was also a period of extremely mild weather which also interfered with the work progress. In general, the weather was unfavourable for construction. The total number of workers on the Ontario Hydro section of the project was 3,550 persons.

Progress By Ontario Hydro

Excavation of the mile-long Cornwall diversion canal was virtually completed in January. A total of 1,100,000 cubic yards of material was removed from this new channel. It will take ship traffic through the power-house construction area while the dike is being completed over the old canal, and will be used until the time of flooding the headpond area.

Construction of the concrete closure structure had been completed in November. Removal of the plugs at either end of the canal was getting underway. At end of January only the placing of rip-rap on the slopes of the canal remained to be done to prepare the diversion waterway for shipping in April.

Despite extremes in weather, concrete placing continued around the clock on the Ontario Hydro half of the power-house. To the end of the month, a total of 430,000 cubic yards of concrete had been placed in the permanent structures on the power-house site. Concrete placing was proceeding in all units out to No. 8, and also in the three ice sluices. The draught tube form was erected in unit No. 7 and concrete placing was getting underway.

Draught tube liners had been installed in units 3 and 4. Erection of the fourth gantry crane on an 85-ft. gantry on the downstream side of the power-house was completed at month end. This will help to speed up concrete placing operations on the downstream side of the power-house, and also the installation of mechanical parts. At the west end of the project, excellent progress was made on the removal of Iroquois Point. The total excavation now amounts to 700,000 cubic yards, with the material going to disposal areas at Iroquois townsite and dikes in the area. Reinforcing of the swing bridge over the canal at Iroquois was in progress to handle heavy traffic engaged in construction work at Iroquois Point.

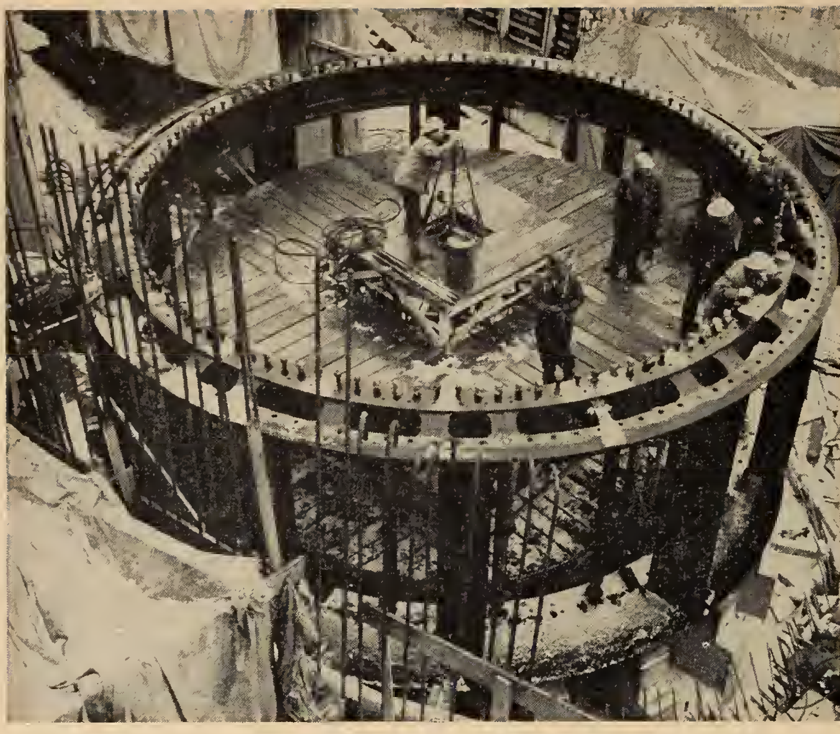
Erection of the new railway bridge to carry the relocated Canadian National Railways double track over Hoople Creek had been completed. Work was about to commence on the bridge over Nash Creek, one of three such structures on the 40-mile stretch of new railway line. Construction of the highway bridge over Hoople Creek also was proceeding favourably. The paving contractor had added five additional miles of base paving to new No. 2 highway west of Ingleside to the Aultsville Road.

Some work was in progress in preparation for dike construction in the spring. The contractor was excavating in the marine clay areas in the vicinity of Mille Roches.

Limited house moving operations were carried out in Morrisburg in January to clear access routes for the major moving program to commence in April. Ten homes had been moved by the end of the month. In the new industrial area of Morrisburg, all services had been installed, and a new track spur had been laid.

At Iroquois, work was concentrated on the new shopping centre. Store fronts were virtually completed and interior installation work was proceeding. Conversion of houses into apartments was in progress, with approximately 30 apartments ready for occupancy. Work was continuing on schools and churches.

An artist's conception of the St. Lawrence power project, when completed in 1960.



St. Lawrence power dam. The stay ring for unit 32 is leveled and aligned

House moving operations were in progress throughout the month at town No. 1 with a total of 32 homes moved by month end. Work was essentially completed on the storage tank, and construction of the sewage treatment plant was virtually completed. At town No. 2, the major program was cleaning up and repairs and renovations to houses recently moved. Some 25 houses remained to be moved into the townsite.

Progress by NYSPA

Despite January's extreme subzero temperatures, progress continued on almost all features of the project. Overall construction was on schedule, as concrete placement to month's end exceeded 34.5 million cubic yards. Employment averaged 2,150 for the month.

At Long Sault dam, removal of the plug at the upstream end of cut F was progressing on a twenty-four hour day basis, concurrently with placing rock fill in cofferdam E. All the flow of the south channel, and part of the flow of the north channel, was being diverted through Long Sault dam. Concrete placement in the St. Lawrence power dam (Barnhart Island power-house) was continued at a reduced rate due to low temperature conditions, as concrete placed to date exceeded 440,000 cubic yards. Concentrated efforts were made to push the placement of concrete in ice sluices 5 and 6 and in the intake piers. Concrete continued to be placed in the switchyard walls and in transmission line tower footings.

At Iroquois dam, the stage II cellular cofferdam to the Canadian shore was completed, the construction area unwatered, and excavation started. Removal of the upstream stage I cofferdam continues.

At Massena intake, cofferdam cells were being driven and excavation for the upstream diversion channel continued. Installation of electrical and mechanical equipment inside the structure progressed satisfactorily. The elevator hoist machinery was installed.

Excavation under the five channel improvement contracts was hampered during part of the month by extremely cold temperatures. Due to difficulty in ferrying personnel and supplies to Toussaints Island, equipment was moved to the mainland and placed in operation on Sparrowhawk Point.

Construction work on the relocated highway routes 37 and 37B continued during the first half of January, but at month end both contractors had suspended all construction activities until spring. Progress on both highways was ahead of schedule. Work continued at a reduced pace on the rehabilitation of the Massena-Taylorville transmission line due to the severe weather. Clearing of the right-of-way for the Barnhart-Plattsburgh transmission line was progressing on schedule. Bids were received for a 200-Mva. auto-transformer to be located at Plattsburgh.

Continued progress was made by the four reservoir clearing contractors, as 3,000 acres of the required 11,000 acres had been cleared.

Heavy Construction to End This Year

Completion of heavy construction work on the St. Lawrence power project by the end of 1957 was forecast by NYSPA. Another goal cited was the opening of the river between Montreal and Lake Ontario to 27-foot draught vessels at the start of the 1959 navigation season.

These and several other predictions were contained in an illustrated 52-page progress report prepared by the Authority for Governor Averell Harriman and the state legislature.

Present plans call for the flooding of the power pool on July 1, 1958, he said, with the first power being produced by September 1, 1958.

In addition, the report said the authority has assured a market for all St. Lawrence project power.

Robert Moses, Authority chairman, said that contracts had been signed with Aluminum Company of America, the state of Vermont, the city of Plattsburgh and the Plattsburgh air base. Also, he said, "contracts have been negotiated with Reynolds Metals Company and Niagara Mohawk Power Corporation, thus assuring a market for all St. Lawrence power and sufficient revenue to pay for maintenance."

Progress by SLSA

With the labour force reduced to some 3,500, most of the work on navigation channels during January was on the locks. At the Iroquois lock 161,000 yards of concrete had been placed to date on the upper approach wall and the upstream end of the lock. Nearly four million yards of excavation was completed. No concrete was poured during January at the Cote Ste. Catherine lock. At the upper Beauharnois lock 310,000 yards of earth and 343,000 yards of rock had been excavated to date and the mixing plant was ready to operate. On the lower lock 230,00 yards of rock had been taken out to date and 22,000 cubic yards of concrete poured in the underpass. At the St. Lambert lock placing of concrete was just being resumed after a two-month shut down.

At Mercier bridge, the contractor was working on the embankments for the approach roads, and had started pouring concrete pedestals. At the Jacques Cartier bridge, temporary southbound and northbound lanes were opened for traffic, and cladding of the piers was virtually completed. Work had started on the new south shore abutment and preparations were being made for lifting the superstructure spans. At the Welland ship canal, with work completed between locks 1 and 2 and between locks 3 and 4, work was continuing between locks 2 and 3 in the dry and drilling was proceeding at the Port Colborne end.

A contract to John Entwistle of Cornwall was awarded January 4 for the construction of a temporary water supply installation to supply clean water to the Courtaulds plant at Cornwall, during construction of the seaway. The contract is valued at $176,000 and the work is to be completed by April 30, 1957.

Award of a contract for supply and erection of the steel superstructure from pier 14 to pier 29 of the proposed south extension to Honoré Mercier bridge near Montreal was announced January 8. This superstructure will be some 1883 feet in length. The contract was awarded to Dominion Bridge Company Limited, of Montreal. It is valued at $2,503,-218. Purpose of the extension is to provide a high-level crossing for motor traffic over the seaway channel.

By November 30, 1957, the contractor will complete fabrication to such state that erection may actively proceed, at which date the concrete piers are scheduled for completion by another contractor. The work is to be entirely completed by May 31, 1958.

A contract for suction dredging of 9,400 feet of the Welland ship canal in Port Weller harbour at the Lake Ontario entrance was awarded on January 9 to the J. P. Porter Company Limited, of Montreal, at a price of $642,600. Dredging at the lower entrance to lock No. 1 is to be done during the non-navigation season this winter. The whole of the work is to be completed by July 31, 1957.

(Continued on page 313)

What Goes On

Canadian Car and Foundry, Limited

A three-year, $15,000,000 plant construction and integrated modernization program, was announced at the end of January by E. J. Cosford, president and managing director of Canadian Car and Foundry, Limited. Can-Car is a member of the A. V. Roe Canada Limited, and Hawker Siddeley Group of Companies.

By this program the company's Dominion plant at Ville St. Pierre, Que., will be enlarged to nearly double its present manufacturing area, with new facilities for the production of stainless steel equipment. Production capacity of stainless steel cars is estimated at 80 units a year.

Canadian Steel Foundries (1956) Limited

Construction of a plant in Montreal for the production of wrought steel wheels for railway freight and passenger cars and for diesel locomotives is announced by Canadian Steel Foundries (1956) Limited. New equipment valued at $4,000,000 will include a battery of heavy machines for forging, pressing, rolling and heat treating; the latest equipment in mechanical and materials handling; electric furnaces and machining facilities.

The firm is a relatively new member of the A. V. Roe Canada Limited and Hawker Siddeley Group of Companies. It was formerly a division of Canadian Car and Foundry Company, Limited.

Shawinigan Water and Power Company

The Shawinigan Water and Power Company and the Power Corporation of Canada Limited, jointly announced recently that agreement had been reached on the terms of an offer by Shawinigan to acquire Power Corporation's holdings of 199,975 shares (49.9 per cent interest) in Southern Canada Power Company, Limited's common stock on a share exchange basis. The same exchange offer will be extended shortly to all other Southern Canada common shareholders. The preferred shareholders of Southern Canada will not be affected.

The effect will be the ownership by Shawinigan of 70 per cent of Southern Canada's common shares.

It is believed the closer relationship of Shawinigan and Southern Canada companies will be of benefit to the territories served by both companies.

International Nickel Company of Canada, Limited

Preliminary construction was commenced in December on a new 12-million dollar concentrating plant for the International Nickel Company of Canada, Limited.

Located on a site adjacent to the Company's Levack Mine, the mill will have a rated capacity of 6,000 tons per day. It will form part of a continuing program to provide for more effective utilization and efficient treatment of the Sudbury ores. It will produce both nickel sulphide and copper sulphide concentrates.

Contract for the new mill building has been let to the Foundation Company of Canada.

Dominion Bridge Company, Limited

A $20 million expansion program announced by Dominion Bridge company as a four-year project, will affect the whole company network, increasing productive capacity by approximately 40 per cent.

In the Eastern Division there will be an office extension at the Lachine plant, a plain steel warehouse and additions to the structural steel fabrication shop; new fabrication facilities at Robb Engineering Works, Limited, Amherst, N.S.; a new plant in Ottawa.

The Ontario Division will receive a new steel fabrication shop in Toronto.

Principal expansion in the Western Division will be in the Edmonton area, a large structural fabrication, shop. At Calgary a fabrication aisle will be enlarged.

In the Pacific Division, the program will follow several expansion stages which have already taken place during the past few years at the company's two Vancouver plants.

Tender for Fertilizer Plants

A request for tenders has been received from the Commercial Secretary, Office of the High Commissioner for India, in Ottawa. This tender may be of interest to Canadian engineering companies.

The tenders are invited for supplying a group of fertilizer plants, designed for the production of nitrolimestone (20.5% nitrogen) starting from hydrogen, of electrolytic purity, and limestone.

The request for tenders, with full details and specification, is available for inspection at Institute headquarters. Tenders are to be received by parties in New Delhi, India, and in New York, N.Y., by May 15, 1957.

Canadian Pipeline Project

Westcoast Transmission

Frank McMahon, president, announced in mid-January that at the close of the 1956 construction season more than 70 per cent of the pipe was laid in the ground, and that the entire project, including river crossings, compressor stations and measuring stations, was on schedule. He said his company would provide the sales outlet for the largest potential gas producing area served by one natural gas pipeline.

Mr. McMahon believes the proposed union of El Paso Natural Gas and Pacific Northwest companies will, when completed, provide increased market areas for Westcoast gas supplies from Alberta and B.C. fields. This new deal, whereby El Paso acquires full ownership of Pacific Northwest for $150 million, gives the former company ownership of 11 trillion cubic feet of reserves, over 2,300 miles of pipeline with 339 billion cubic feet daily of capacity, 304,000 acres of leases and 246 producing gas wells, making it the world's largest pipeline system. The company holds a 25% interest in Westcoast Transmission.

A Canadian financial house has estimated that Westcoast's earnings in its first 12 months of regular operation commencing in 1958, will reach approximately $14½ million or $2.90 per share outstanding. Revenue is predicated on the assumption that movement of gas under present contracts for firm deliveries, for additional option purchases and for still further extra amounts, will total around 750 million cubic feet daily in the 12-month sample period. Firm and option deliveries are slated to rise to 849½ million cubic feet daily starting in 1961, but growth in demand and pipe facilities are seen as making it possible that deliveries will rise to 1 billion cubic feet daily in 1961 and to 1½ billion feet by 1963. On this basis it is calculated earnings would increase to $4.10 per share in 1961 and to $5.80 per share in 1963.

Inland natural gas planned to start work on its distribution systems on February 1. First on the program was the Penticton system, with Kelowna following on February 15. The Nelson system was to be started on March 15; work will start at Williams Lake and Quesnel early in April and at Trail in July. Award of a $9 million contract to build the main pipeline was awarded last September. Prior to that, orders had been placed for pipe, to be manufactured in Canada, amounting to $6½ million.

Already enthusiasm for modern firing of industries with natural gas has raised Inland's commitments to Westcoast. No rate structure has yet been announced but it has been stated that rates will be competitive and as low as those paid by users in the coastal areas of British Columbia.

Completion of Inland's entire pipeline system is expected by September this year.

Savanna Creek Gas

The Northern Natural Gas Co. will apply to the Petroleum and Natural Gas Conservation Board of Alberta for permission to take natural gas from the Savanna Creek field to destinations in northern states, including Minneapolis. Northern's Canadian subsidiary has a 32½% interest in the Savanna Creek field. The proposed pipeline would presumably be in substitution for the one projected recently by Westcoast Transmission Co. for export of Savanna Creek gas to the Pacific northwest.

The Westcoast announcement had referred to a contract with Phillips Petroleum Co., which holds 27½% interest in the field. The new Northern Natural Gas plan would take the gas via Coutts, Montana, to connect with Northern's large existing system. No agreement has so far been reached on compromise plans in connection with a proposal for export of Canadian gas by Trans Canada Pipelines to a subsidiary of Tennessee Gas Transmission. Trans Canada officials had made no comment up to the end of January.

Trans Canada Pipelines

J. L. Parrish, chief engineer, speaking for Charles S. Coates, executive vice president and general manager of Trans Canada, told the Pipeline Contractors' Association meeting in Florida, on January 15 that his company expects to have 1300 miles of its 2250 mile pipeline in the ground by the end of this year. This means laying 1000 miles during 1957. To date some 230 miles had been laid on the line to Winnipeg and contracts awarded for the balance of the 574 miles. Digging of the pipe trench might not be resumed until June, he said, but gas would reach Winnipeg by August or September. Two vital events in the immediate future were the financing of the project and FPC approval of export-import proposals.

Mr. Coates' report also stated that the 30-inch pipe would be laid as far as Port Arthur during the current year, as well as the 310-mile Toronto-Montreal 20-inch leg. The Port Arthur-Toronto gap would be bridged in 1958. Thus gas services from the all-Canadian line would be available at all points along the initial system by the fall of 1958.

According to an announcement last September, Montreal deliveries by Trans Canada are to be taken and distributed in this area by a new company, to be formed to acquire producing and distributing facilities of Hydro-Quebec. This company could presumably be formed this year and could commence distribution of gas supplies which are presently being purchased for use in Toronto (via Buffalo) from Tennessee Gas Transmission Co.

Meantime, the Tennessee-Midwestern case, on which FPC hearings are being conducted at Washington, remains where it stood last November when the Federal Power Commission rejected applications from the competing natural gas companies to throw out the Tennessee-Midwestern proposal to import 204 million cubic feet of Canadian gas daily via Emerson, Manitoba.

In addition, Tennessee-Midwestern want to export gas to Eastern Canada to build up the Montreal market pending the arrival of Alberta gas. The way the hearings are going at Washington many months may pass before a decision is handed down, and after that the case may be appealed before the Supreme Court of the United States. Thus the all-Canadian pipeline may be built and operating before the case is resolved.

Crown Company Gets 'Go-Ahead'

The federal government on January 30 announced it had authorized a start on construction of the northern Ontario leg of the pipeline. The Crown Corporation will complete laying of the pipe from the Manitoba boundary to Port Arthur by November 1, 1957, and the rest of its portion to Kapuskasing by November 1, 1958. On its part, Trans Canada has agreed to complete the prairie leg to the Ontario boundary by Nov. 1, 1957, and to complete the rest of the line from Kapuskasing to Montreal by November 1, 1958. The government is now satisfied that Trans-Canada has completed arrangements for financing of all the costs for its portion of the construction.

The Saskatchewan Power Corporation is seeking to purchase the output of natural gas from the Many Island gas field just west of the Saskatchewan-Alberta border. It claims gas from this field would be cheaper than gas purchased from the Trans-Canada pipeline. The intention would be to connect the field up with the 120-mile gas pipeline built in 1956 to bring gas to the city of Moose Jaw from the Success field in southwestern Saskatchewan.

The City of Medicine Hat, Alberta, opposes this purchase however, and even if the Alberta Conservation Board should decide in favour of the Saskatchewan proposal, the Corporation must apply to the Transport Board for approval of a pipeline route, before approval will be given by the Alberta Government for export.

The First "Argus" Completed

The first flight of the Argus is scheduled for April 1957.

Canadair Limited, Montreal, has developed the CL-28, now named the Argus, to meet the exacting requirements of the Royal Canadian Air Force for a long range maritime patrol aircraft. The first two craft will remain at Canadair for testing purposes, and the RCAF will take over the third later in the year.

"The primary role of the airplane" it was explained by E. H. Higgins, Canadair's chief project engineer "has been stated by the RCAF to be the shore based air seaward defence of Canada, in the Canadian Atlantic sub-area, in conjunction with the R.C.N."

Although the Argus has been developed from the basic design of the Bristol Britannia series of transport aircraft, the military requirements have resulted in very extensive changes for its specialized role.

The complex equipment provided for communication, navigation and submarine detection requirement; includes an extensive number of separate electronic systems and a wide range of the most recent armament equipment.

The giant aircraft is 128 feet long, with a wing span of 142 feet, a height of 36 feet. Its cruising range is more than 4,000 miles, cruising speed, 175 to 200 m.p.h., maximum altitude 20,000 feet.

It is powered by four Wright piston turbo-compounded engines, instead of the Britannia's turbo-prop engines. This power change will give the Argus very long range at low levels and moderate speed, as required for its special tactical mission.

The Bristol Britannia was completely redesigned, employing North American standards and materials, to ensure that the Argus can be produced and maintained in Canada under wartime conditions. Its completion was preceded by a vigorous program of laboratory testing of the major systems, the airframe components and power plant.

The Argus, it is reported by the RCAF, will be the best fitted anti-submarine aircraft in the world with respect to modern electronic and other equipment. With its coming into service the Avro Lancaster, a wartime bomber, now being used by RCAF's Maritime Air Command, will be gradually retired. The recently acquired Lockheed P2V-7 Neptune, medium range patrol aircraft, will remain in service.

The Argus will be capable of flying more than 1000 miles from its base and remaining there for a considerable time on patrol. If necessary it can divert to an alternate field within a radius of 500 miles from base with normal fuel reserves. It has a combat range of more than 4000 miles. It will carry torpedoes, depth bombs and a variety of weapons, as required for patrol mine laying or torpedo bombing.

The program of the Engineering Institute's annual meeting this year at Banff, Alta., June 12-14, will include a technical paper on the Argus.

Transatlantic Telephone Cable

The Canadian Overseas Telecommunication Corp., is considering further transatlantic telephone cable facilities, Douglas F. Bowie, president and general manager, said recently.

Mr. Bowie was commenting on a London dispatch quoting the *Financial Times* as saying the United States and Canada have under discussion the possibility of a second cable because of the great volume of calls that followed completion of the first cable.

Mr. Bowie's statement said:

"Public use of the transatlantic telephone cable which was launched on September 25, 1956, has exceeded all expectations and it has become necessary to give serious consideration to providing more facilities".

(CP. Report, Feb. 20, 1957)

E.I.C. Annual Meeting

Banff, June, 1957

"Overseas Telecommunications" wilil be the subject of a paper by R. G. Griffith, M.E.I.C., of Canadian Overseas Telecommunication Corporation.

Presenting views of New York, London, and Montreal groups, meeting simultaneously on January 24, 1957, and with proceedings linked by transatlantic telephone cable service. This unique meeting was reported in the February issue, page 144.

London. Here the meeting was arranged by the Institution of Electrical Engineers. Sir Gordon Radley, president, is seen (left) expressing greetings of I.E.E. Also shown: Dr. R. C. G. Williams, chairman of the Radio and Telecommunication Section, Dr. R. A. Brockbank and R. J. Halsey, of the British Post Office, authors of papers.

Montreal. At the meeting sponsored by the Engineering Institute of Canada the participants were: Douglas Bowie (left) president of the Canadian Overseas Telecommunication Corporation; Thomas W. Eadie, president of The Bell Telephone Company of Canada; R. G. Griffith, chief engineer of C.O.T.C., and V. A. McKillop, president of the E.I.C.

The New York end of the conference took place at the winter general meeting of the American Institute of Electrical Engineers. Those participating in New York are (left to right): M. J. Kelly, president, Bell Telephone Laboratories; T. F. Gleichmann, Bell Laboratories; J. S. Jack, A. T. & T. Long Lines Division; H. A. Lewis, Bell Labs; A. N. Lebert and E. T. Mottram, of Bell Labs, and M. S. Coover, president of AIEE.

Power Developments in Newfoundland

St. John's, Corner Brook, Grand Falls

The Newfoundland Light and Power Company Limited, St. John's, has reported an expected total load growth in 1957 of close to 22 million kwh., in the St. John's, Corner Brook, and Grand Falls areas. The company has been reporting rapid load growths in the past ten or twenty years.

In 1956 a 10,000-kw. steam generating plant at St. John's was completed, the first steam turbine station in the system. The installation, costing $1,990,000, and developing a site that can be used for two more units of 20,000 each, features a new electronic system of boiler control, the first of its kind in Canada.

Future planning for the St. John's division of the company, as reported by V. A. Ainsworth, general manager, includes the addition of a 10,000-kva. generator at the Pierre's Brook hydro plant to provide peak capacity in 1958, and the addition of a 20,000-kw. steam unit at the St. John's steam plant in 1959. There is also a plan that will give remote control of all plants and substations from a central load dispatching point by 1961.

It is anticipated that the load in St. John's will reach 270,000,000 kwh. per year, with a peak of 63,000 kw., by the end of 1961.

In the Grand Falls area, construction is to start in the spring of 1957 on a power plant on Rattling Brook, Norris Arm, about twenty miles from Grand Falls. Completion date is scheduled for late in 1958 at this site, which is capable of 8500 hp. continuous. This development is the result of the agreement, made when the distribution system in this area was purchased from the Anglo Newfoundland Development Company, that the Power Company would develop a source of power immediately.

In the Corner Brook area, where power is purchased from Bowaters for distribution, plans are for urban and rural distribution extensions only.

Trinity Bay and Conception Bay

Two more power developments into operation in December, 1956, in Newfoundland, the New Chelsea power house at Trinity Bay, and the project at Manuel's River on the shore of Conception Bay.

These new installations of the United Towns Electric Company Limited, designed to expand its power resources, will add, in 1957, 20 million kwh. to the company's annual output. The company is affiliated with the Avalon Telephone Company, of St. John's, Nfld.

The Avalon company, through W. J. Carew, reports expansion of United Towns' operations during 1956 to 55,138,590 kwh. generated. There are other expansions being contemplated for Lookout Brook, on the West Coast, and in Burin Peninsula.

The $2 million New Chelsea project was developed in three stages.

Two areas totalling nearly seven square miles, in the vicinity of Crooked Pond and Ocean Pond, are adjacent to Big Brook, and their outlets formerly drained into Conception Bay. These waters have been turned into Pitmans Pond and the combined resources of all these headwaters are now fed into the powerhouse at Big Brook.

The work at Manuel's River consisted of the creation of a reservoir, five sq. mi. in area. A compacted earth fill dam, 37 ft. high, raises the water surface to a height of 30 feet, which is sufficient to divert it into a 3,600-ft.-long canal, into an existing reservoir and penstock which feeds the power plant at Topsail. This plant is thus ensured of a continuous 24-hour production, and its output is increased to 8,260,000 kwh. annually.

This development as well as the New Chelsea one was carried out by the Power Corporation of Canada.

New Brunswick Power

Exploration work being carried on in New Brunswick is continuing to reveal valuable new ore bodies, rating the province's mineral finds as some of the richest in North America, it is reported by the N.B. Electric Power Commission.

The commission, planning to provide economical power to domestic customers, and to light and heavy industry, lists as potential power users the mining companies at present either processing, consolidating or expanding their mineral discoveries. Chemical industries, pulp and paper mills, and others must be served also.

The demands for large blocks of power are already known. The immediate and longer term plans feature a pattern of interconnection of generating facilities within the province, and within the whole maritime area and a tie-in with a utility in the State of Maine.

In the past year a reciprocal arrangement interconnecting the Commission's grid system with five of the major pulp and paper companies for the purchase and sale of surplus power was mutually beneficial. The Commission thus obtained 29 million kwh. for resale, while 44 million kwh. of off-peak power from the Commission generating stations was supplied to the paper companies.

Actual hook-up of N.B. Power Commission with facilities of the Maine Public Services, a privately owned utility, is set for an early date this year.

The power pool idea has been endorsed in principle by the three Maritime governments, and a special committee has been set up by the Atlantic Provinces Economic Council to study and report on the plan. Only New Brunswick and Nova Scotia are now represented in this special power group. Though Prince Edward Island is not now in the plan, the theory is that a hook-up with P.E.I. could be accomplished by submarine cable across the Straits of Northumberland or via the proposed causeway.

The potential market for power is great. Even after the 102,000-kw. Beechwood hydro development begins transmitting its power, the Province may require a further 532,000 kw. to supply the demand in the next decade.

An orderly program of construction of generating facilities has been designed. Steam units are planned, to be integrated with developments on the St. John and other rivers.

A thermal plant at Chatham was added in December 1956. Work on the Beechwood hydro development on the St. John River is going forward well ahead of the original plan of construction. Construction of the 30 million development, with contractors Foundation Maritime Ltd. in charge, continued through the fall and winter.

Tidal power as a source of electrical energy, long a subject of speculation, received particular attention in 1956. The International Joint Commission has authorized a comprehensive study of the technical and economic feasibility of the Passamaquoddy Tidal Power project.

CF-100 Flight Simulator

Acceptance of the first production model of the CAE CF-100 Flight and Weapons Systems Simulator on February 12 by the government and the air force marked an advance in Canada's aviation and electronics industries.

The simulator reproduces on the ground the flight, engine and weapons systems characteristics of the actual aircraft. Eleven models will be built at the Canadian Aviation Electronics Company plant in Montreal.

The Rt. Hon. C. D. Howe, Minister of Defence Production, for the government, and Air Marshal C. R. Slemon, Chief of Air Staff, for the Royal Canadian Air Force, accepted the first model from K. R. Patrick, president of CAE.

The simulator consists of an exact replica of the CF-100 cockpit, an instructor's console, and a number of computers. It is a training device familiarizing the aircrew with the behaviour of a specific aircraft rather than with general flight and instrument performance. Basically a computer of the "analogue" type, it will allow three distinct types of aircrew training: transition and familiarization; training in emergencies; tactical training in interception techniques.

Operation and Techniques

During simulator operation, controls and instrumentation provide complete information concerning flight conditions, engine performance, enemy activity and so on. The flight and radar instructors are provided with duplicate sets of instruments together with a scoring system that measures crew proficiency.

Instrument readings, from which the operational data of an aircraft are taken, are basically instantaneous solutions to the complex differential equations that govern the behaviour of an aircraft in motion. Individual terms of these equations are derived primarily from displacement of the aircraft controls such as control column, throttle, rudder bar, etc., and in flight are added, multiplied and integrated automatically by the aircraft itself. Analogue computers make possible the solution of these equations and their display upon real or simulated flight instruments and recorder charts.

Variable quantities, such as lift, drag, weight, angle of attack, etc., are presented to analogue computers as "machine variables" or voltages and shaft rotations which are made to obey the same mathematical relationships existing between the original variables. The processes used in computing occur at the same rate as the processes they represent in the actual aircraft.

Civilian Application

Recently Canadian Pacific Airlines placed an order for a DC-6B simulator with Canadian Aviation Electronics, the first Canadian airline to order a full simulator. This will be the first commercial model to be built in Canada.

Mineral Industry in Nova Scotia

Increased production marked the progress of the mineral industry in Nova Scotia in 1956.

The total value of the industry well exceeded the $66 million mark, of which coal accounted for $50 million. Coal production is again on the increase after a slight recession felt in recent years. Aiding in the improvement have been several factors. Increased mechanization has reduced mining and transportation costs; new washing and screening methods have been introduced, and a new downdraft automatic coal burning furnace is being marketed.

Nova Scotia produced during 1956 more than 80 per cent of the total Canadian output of gypsum. Production reached 4 million tons, practically all of which is shipped in crude form to mills on the Atlantic seaboard of the United States.

The Canadian Gypsum Company is investing $2½ million in a new quarry; the National Gypsum (Canada) Ltd., has developed a new quarry and has extended shipping facilities. The Bestwall Gypsum company has obtained property at Cheverie and at Milford, and development will proceed. The Johns Manville Company is reported to have taken options on tracts in the vicinity of Milford.

The province produces 90 per cent of the Canadian output of barytes. A new development is the plan to adopt the underground mining method; a contract has been let for a new 900-foot shaft to tap large tonnages of proven barytes ore reserves.

The Malagash Salt Company Ltd is developing a new salt deposit at Pugwash, and will invest $1 million in new buildings, machines and marketing arrangements.

Production of sandstone, granite and clay products continues profitably. Petroleum field exploration has been undertaken over large tracts by Imperial Oil Co. Ltd. Prospecting for base metals continued at a high level.

Ontario Hydro's Golden Jubilee Year

Ontario Hydro observed its Golden Jubilee in 1956.

During Hydro's first fifty years, the population of Ontario has more than doubled, to over 5 million. The gross value of manufactured products has jumped to over $9 billion and mineral production to $584 million.

Primary power requirements for all systems were 4½ million kilowatts in 1956. This would more than absorb the output of the additions to the Commission's power resources and its modest reserves. This situation will be improved as resources now under construction are placed in service during 1957. For the time being, it emphasizes the value of Ontario Hydro's interconnections with neighbouring states and provinces.

Construction presently under way on nine separate projects, including new plants and additions, will add over 2 million kilowatts to present resources within the next four years. By 1980, power demands may be four to five times what they are today, which means that resources totalling more than twenty million kilowatts will be required, much of which will be provided from thermal sources.

In the light of these facts, the ceremonies on September 19, 1956, launching construction of Canada's first nuclear-electric plant on a site near the Commission's Des Joachims station on the Ottawa River, assume the highest significance. It is expected that the operation of the 20,000-kw. NPD plant will provide valuable information and experience for future development of electric power from nuclear sources on a much larger scale.

Further evidence of the active role which Hydro is playing in nuclear research is to be found in the financial assistance being given to McMaster University for work associated with reactor installation, operation and studies. Ontario Hydro provided a grant of $100,000 during 1956 and will give a further $100,000 in 1957. In addition, $5,000 per annum will be provided for over ten years to assist in the operating costs, associated with the reactor.

Progress at Niagara

In the Niagara area, four additional 75,000-kilowatt units of the Sir Adam Beck-Niagara Generating Station No. 2, are scheduled to be in service by 1958. These, along with the 170,000-kilowatt pumping generating station, scheduled for service in 1957, will bring the installed capacity of this plant to its ultimate of 1,370,000 kilowatts.

Considerable headway was also made during the year on the remedial works program being undertaken jointly by Ontario Hydro and the Corps of Engineers, U.S. Army.

News of still further expansion of Hydro's southern Ontario system came during 1956 with the announcement that three 200,000-kilowatt units will be added to the Richard L. Hearn generating station at Toronto. Already this is the largest thermal-electric plant in Canada, and the additional units will bring its total capacity to one million kilowatts. At the same time, the Commission is considering the possibility of building a steam plant at Hamilton using a site which is owned by the Commission at the waterfront.

Northern Ontario

In northwestern Ontario, an area which comprises more than half the province, Hydro's power demands had increased in December, 1956 by 6.1 per cent over the corresponding period of a year ago.

This part of the province, from the standpoint of its potential development, is described as "the richest area in the world", and its population should double in the next 20 years.

New Power Plants

At Whitedog Falls on the Winnipeg, a 54,000-kilowatt plant is being built, scheduled to come into initial service in December, 1957. The following year, the 67,500-kilowatt Caribou Falls station on the English River is scheduled for first operation. Extensions are being made to the Alexander and Cameron Falls plants on the Nipigon River that will increase the resources of the northwestern division by 30,400 kilowatts by 1958. Looking even farther ahead Hydro crews have test-bored the lakehead area for possible thermal-electric generating station sites.

In October, 1956, arrangements were completed for the first exchange of power between the facilities of Ontario Hydro's Northwestern Division and the Manitoba Hydro-Electric Board. It is now possible for these two systems to exchange power and to co-operate in utilizing the flows of the Winnipeg and English Rivers to the best possible advantage. The interconnection was made through Ontario Hydro's new switching station at Kenora.

Frequency Standardization

During 1956, the 60-cycle frequency standardization program in southern Ontario advanced substantially. From October, 1949, when it was started, up to November 1, 1956 a total of nearly five million appliances had been changed from 25 to 60 cycles for 739,202 Hydro customers. It is estimated that over six million appliances will have been altered by the time the southern Ontario changeover program has been completed in 1959. Plans for 60-cycle frequency standardization in Hydro's northeastern division were announced in September.

St. Lawrence Seaway

(Continued from page 307)

The Hon. George Marler, Federal Minister of Transport, announced that tenders would be called in the spring for the proposed new highway bridge across the St. Lawrence at Nun's Island opposite Montreal, if all formalities could be cleared by that time. The National Harbours Board would also consider adding a fifth traffic lane over the Jacques Cartier bridge when conditions warrant it, he said, but not before better approaches are provided on the Montreal side.

The speaker intimated that the federal government would be spending a total of some $40 million on improvement of highway communications between the island of Montreal and the south shore arising out of seaway development.

Discussing seaway traffic, he expressed the view that American ports would handle the bulk of overseas shipping using the Great Lakes when the seaway opens. Traffic on the lakes had increased substantially since 1945 and would be further developed when the seaway is finished. He predicted that U.S. Great Lakes ports, rather than Canadian ports, would be the terminus for more goods, because of the greater population on the American side of the Lakes.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE
ELECTIONS AND TRANSFERS

E.I.C. Conference on Engineering Education (1956)

Since the Institute's Engineering Education Conference was held in May, 1956, the committee consisting of Deans R. E. Jamieson, H. Gaudefroy and H. Conn have been busy working on the verbatim and the resolutions.

The committee has met at least three times at three different centers and has recenty produced documents which mark the second stage in the conference development.

In the first place, the committee has circulated an abstract of the very voluminous verbatim. A copy of this has gone to every one of the sixty people who attended the conference. The verbatim itself has been circulated to each university so that each person may have an opportunity to study what was said, thereby refreshing his own recollections of the conference.

Recently the committee circulated a very exhaustive questionnaire — eight pages in length. This questionnaire has gone to every dean of engineering in Canada, with the suggestion that the information be compiled carefully and then returned to committee for study.

The questionnaire provides graphs wherein may be recorded information such as undergraduate degree, and sessional fee, admission requirements, maximum number of students in teaching groups, draughting room sections, laboratory groups, staff teaching load, attendance records, amount and type of shopwork, surveying field work, draughting hours, laboratory reports per student per session, industrial experience requirement, academic standing and promotion, record of academic performance, —from first, to second, to third, to fourth and to final years, and so on.

At the conference itself it was noticed that practices varied considerably from institution to institution.

Once this questionnaire has been completed and analyzed, the differences in teaching methods and procedures can be readily noted and the methods of one institution as compared to another can be studied.

The committee plans to compile all the information and then to recirculate it to every person who participated in the conference. It is believed that under these circumstances the educators will have in their possession for the first time the real story of how engineering is taught in Canada. From such basic information the conference will be able to plan very wisely for the future.

It is expected that when the information is finally compiled it will be published in the *Engineering Journal* so that it will be available not only to the educators themselves but to all members of the profession.

Historical Biography

Shortly the Institute will be in the book publishing business. A four hundred and sixty page biography of two great Canadian engineers is being published under the Institute auspices and will be on the market by late Spring.

For some time people within the Institute have been talking about the possibility of bringing back to the public's attention, the careers of distinguished engineers who helped build up this great country. In some instances distinguished people such as Sir Casimir Gzowski and Sir Sanford Fleming have had their biographies published but there were many other giants of the profession associated with them whose records have been buried for almost a hundred years.

Some time ago the Council of the Institute agreed that the Institute would sponsor some worthwhile biographies of this nature. At the moment there are two in hand. One is now being printed and the other is in manuscript form and at this moment is up for final checking and approval.

Cover Picture

Jets of industrially clean water are sprayed on to rolled steel plate in the final cooling process at the Dominion Foundries and Steel Company rolling mill in Hamilton, Ont.

Photo courtesy The Permutit Company of Canada Limited

The first book will deal with the lives of Walter and Francis Shanly. Walter Shanly was a founder member of the Engineering Institute of Canada and was a vice-president in 1887. His brother was more concerned with the business side of their various enterprises but between them, they did much to shape the character of Canada.

The story of the Shanlys is a fascinating one and is an integral part of the history of railroad building and Canada's development. They did tasks both in the United States and Canada that put them in a special class of engineers and contractors. They completed successfully projects which had had to be abandoned by other firms because of inability to complete them.

In the process of doing all this they became wealthy men and Walter was a member of Parliament for Upper Canada.

The story has been told fascinatingly by Dr. Frank N. Walker of Toronto. Dr. Walker's degree is in medicine and not in engineering and members of the engineering profession are indeed greatly indebted to him for the fine work which he and Mrs. Walker have done and which they have made available to the Institute.

It is hoped that the biography will be available by the first of May.

It will be an impressive publication and probably will sell in the neighborhood of six dollars. It will be unique in the history of Canadian pioneers and in the history of The Engineering Institute.

To make the book a success commercially it will be necessary to have the support of the members of the Institute. It is hoped that the general public, too, will be interested but the principal field must lie within the profession itself.

In later issues of the *Journal* there will be extracts from the biography so that the membership may bit by bit get to know in advance something of the great men who fill its pages. This will be done in the hope that by the time the book becomes available many appetites will have been whetted.

The second biography has to do with the life of Sir Casimir Gzowski who like Francis Shanly was a vice-president of the Institute in 1887. This will be a complete story telling perhaps for the first time most of the great events of a great man's life. It is hoped that this second biography will be available before the end of the year.

The President Visits Quebec City

The president's visit to Quebec City coincided with the annual meeting of the branch. At this time Ben O. Baker became branch chairman. In this photograph, left to right, Mr. Baker and Louis-Philippe Bonneau, retiring chairman, and President McKillop. The decoration was keyed to the Quebec Carnival, then in progress.

Visitors to Quebec (at right) are Mr. and Mrs. Keith Leighton, of Moncton, and Mr. and Mrs. M. A. Montgomery, of Kitchener, Ont.

Mr. McKillop took this opportunity to present an E.I.C. prize to Jean Real LaHaye, an engineering student at Laval University.

At the annual meeting of the branch: Ben O. Baker, President V. A. McKillop, L. P. Bonneau, and Roger Desjardins, secretary-treasurer.

Transactions to be Published

Another publication of the Institute will make its appearance in the spring or early summer this year. Titled, "Transactions of The Engineering Institute of Canada", it will actually be the resumption of publication of "Transactions" which was interrupted in 1930, and later continued for a time with five "Technical Papers".

This activity received the final approval of Council at the Quebec meeting in January. It had been under consideration by the Publication Committee earlier and the decision was reached that there are now the means and the technical material to present to the membership a useful publication.

The production and editing is now in the hands of the editorial department, and suitable material is being selected for the first issue. Initially, distribution will be free to all members.

Technical Papers

Original technical articles submitted to the Engineering Institute of Canada are reviewed by authorities in the field of engineering concerned, and considered by the publication committee. If acceptable, papers may be published in the regular monthly issues of *The Engineering Journal* or in the *Transactions*.

The *Journal* would receive papers of general interest or of wide application; descriptive articles (e.g. industrial and other installations); papers on subjects that are likely to have a wide readership; papers on designs or processes not too technical in nature.

Papers of specialized technical interest and limited potential readership would be published in *Transactions;* as well as fundamental work of lasting value, likely to be used as a reference paper on the subject (e.g. theory of design); or papers too long for *Journal* use.

Members who have, or know of, papers which might be suitable for the *Journal* or for *Transactions* are invited to inform headquarters.

General Secretary is Society President

The general secretary of the Institute, L. Austin Wright, was elected president of the Council of Engineering Society Secretaries at the annual meeting of the Society in January.

Dr. Wright has represented the Engineering Institute in the activities of C.E.S.S. for many years. He is the first Canadian to hold the highest office in the Society whose 70 member institutions represent some 400,000 engineers in the United States and Canada. His election follows service as vice-president for the past year.

This 32nd annual meeting was held in New York City, on January 14, 15, 16, 1957. The next meeting will be in Cleveland in May, 1958.

Athlone Fellowships

Once again the Institute had the honour and privilege of entertaining Dr. H. H. Burness of the Ministry of Education, London, England, who for several years has come to Canada to select young engineers to whom may be awarded Athlone Fellowships.

Dr. Burness met with the selection committees at Ecole Polytechnique and McGill. Throughout his entire journey across Canada he will be accompanied by Robert Belgrave of the United Kingdom High Commissioner's office at Ottawa.

The persons attending the luncheon in Montreal in addition to Dr. Burness and Mr. Belgrave were Arnold Heckle, United Kingdom Senior Trade Commissioner of Montreal, R. E. Heartz, past-president of the Institute and president of the Shawinigan Engineering Company, E. D. Gray-Donald, chairman of the Montreal branch and vice-president and chief engineer of Shawinigan Water and Power Company, and the following representatives of the selection teams:—

Ecole Polytechnique: Henri Gaudefroy, J. C. Bernier, Robert Brais, Pierre Paul Vinet, Jacques Laurence, Leon A. Duchastel, (representing industry).

McGill: R. E. Jamieson, J. J. O'Neill, G. A. Wallace, D. L. Mordell, J. U. MacEwen, Irving R. Tait, (representing industry).

Unfortunately the luncheon date clashed with an important meeting of the Montreal Board of Trade, of which the Institute's Montreal vice-president, R. L. Dunsmore, is president. Under these circumstances past-president R. E. Heartz presided at the luncheon.

After Dr. Heartz had given the Institute's welcome to Dr. Burness, an opportunity was afforded the guest to tell something of the Athlone Fellows in England and the prospect for more Fellows through the various universities across Canada this year. It was nice to hear that the Canadians had done so well in the Old Country and that the candidates for this year were well up to standard.

The meeting was held at the University Club.

Award of Merit

At each Triennial Reunion, the Engineering Alumni Association of the University of Toronto presents two medals to two outstanding graduates in engineering. To be the recipient of such a medal is an honour which is highly prized.

The purpose of the "Award" is to recognize the accomplishments of engineers, graduates in applied science of the University of Toronto who in a quiet way have contributed greatly to engineering knowledge, or who through their patient and skilful application of their engineering training have been successful in developing methods or machinery for the advancement of Canadian industry, or whose accomplishments had contributed to the comfort, convenience or welfare of humanity.

The Engineering Alumni Association has appointed a committee, representing the different branches of engineering, to receive nominations for this "Award". In sending forward a nomination, details of the achievements and merits of the nominee must be given. This would include such information as the year of graduation, the department from which he graduated; any specialized post graduate courses taken; the special field in which he has worked and particulars of his contributions to the science of engineering and public welfare.

Nominations should be sent before July 31, 1957 to J. Dudley Barnes, secretary, Engineering Alumni Medal Committee, c/o Canadian Standards Association, Box 506, Weston, Toronto 15, Ont.

E.I.C. Annual Meeting, 1957

■■ Principal theme of the technical meeting this year is Production and Distribution of Natural Gas and Oil in Canada. On this subject there will be a total of eight papers.

■■ Some other highlights of the technical program are papers on:

Kelowna-Westbank Floating Bridge, W. Pegusch, JR.E.I.C.

Problems of Highway Location in Rogers Pass, J. P. Hague

The Canada-India Reactor, F. J. Bleackley, M.E.I.C.

Future Power Development in B.C., T. Ingledow, M.E.I.C.

Bersimis St. Lawrence Under-Water Cable, O. W. Titus, M.E.I.C.

Engineering The RCAF Maritime Reconnaissance Aircraft, CP-107, W. K. Ebel and E. B. Schaefer

Management Panel.

■■ A program of special interest will be provided for the ladies.

■■ The Alberta annual meeting committee is arranging special projects. A post-convention trip around an oil field may be provided if sufficient interest develops.

■■ In addition to what has been mentioned, the glorious location of Banff itself will have a wide appeal to those who enjoy mountain air and unsurpassed scenic beauty. June is usually a fine month in the Rockies.

■■ Members who plan to travel on the fast C.P.R. train, The Canadian, are urged to make reservations as soon as possible. It is understood that no extra service will be provided on that train for the meeting.

■■ More information will be given in the April issue. Advance notices can be expected by members during April.

Banff, Alberta, June 12 to 14, 1957

Salary Structure for Teachers

The *Journal* continues to publish frequently informational material on education. This article is from the Engineering and Scientific Manpower Newsletter of December 6, 1956. In part it refers to a project on teacher education which is of interest, though it does not apply to universities directly.—Ed.

Once again the Research Division of the National Education Association has given us an invaluable document under the title "Salaries Paid and Salary Practices in Universities, Colleges, and Junior Colleges, 1955-56" (NEA Research Bull., Vol. 34, No. 3, October 1956). The investigation was concerned with conditions in academic year 1955-56, and the report covers 730 institutions of higher learning. Attention was restricted to the full-time instructional personnel teaching nine months of the year. Some of the figures are worth recording. The average salary paid in all colleges and universities surveyed, and for all ranks of teaching personnel, was $5,243. Distribution by rank was as follows:

Professors	$7,076
Associate professors	5,731
Assistant professors	4,921
Instructors	4,087
Median	$5,243

Still more definitive information bearing upon the teaching problem may be anticipated from a research project in progress under the direction of John B. Whitelaw, Chief for Teacher Education in the Office of Education. A pilot study of problems relating to the staffing of the nation's schools and colleges was completed July 30, 1956, and a summary report of results was issued on that date. The pilot study concludes that eight foundation problem factors "must be taken fully into account in any attempts to get more good teachers and to keep them in the profession." The eight are listed as follows:

1. The economic status of teachers;
2. The social status of teachers;
3. Teaching as predominantly tax-supported, public employment;
4. Teaching as predominantly a female occupation;
5. The quality and costs of education that teachers receive;
6. The effect of technology on society and therefore on the function of the school;
7. The current conceptions of the teaching process and what goes on in the school;
8. What society really requires of the school.

A critical inspection of these factors suggests that the study group was more concerned with elementary teaching than it was with teaching in the secondary schools and colleges. In the latter, teaching is not predominantly a female occupation, and the profession as a whole becomes one only by inclusion of the very large numbers of elementary teachers required for our rapidly growing school-age population. If it is proposed to examine the content of the high school curriculum and the quality of the training that teachers receive in subject matter, this intention might profitably receive more emphasis in the summary report. A large and growing segment of the public has serious misgivings about the philosophy of education, which seems to be out of joint with the times and blind to the fact that over 30 per cent of our young people of college age are now entering college, and therefore require sound college preparatory instruction in our secondary schools. This changing pattern is of vast significance in any project that proposes to deal with the staffing of the nation's schools and colleges.

And From New York City

The Advisory Committee on Science Manpower, appointed earlier this year by Hon. Charles H. Silver, President of the New York City Board of Education, recently submitted its report to Dr. William Jansen, Superintendent of Schools. Of unique interest are the Committee's recommendations to provide a suitable climate which would attract science and mathematics teachers and enable them to grow professionally.

The Committee, composed of outstanding persons from the schools, industry and higher education, under the chairmanship of Dr. John R. Dunning, recognized the fact that an adequate salary was one of the most important factors contributing to a suitable environment and it must reflect general economic conditions as well as the status, preparation and professional competence of the teachers. In addition, it recommended a series of specific steps designed to increase the supply of secondary school science and mathematics teachers and to utilize the present staff more effectively. Following are the recommendations considered most crucial and requiring immediate action:

1. Postpone preservice education course requirements for a science and mathematics substitute's license to enable the immediate employment of college graduates. Require each substitute to take a minimum of six semester hours in approved courses each year to qualify for the annual renewal of his substitute's license. Permit the substitute to become eligible to take the examination for a regular teacher upon the completion of 24 semester hours in approved courses.
2. Encourage qualified and interested elementary school teachers to take examinations to teach science and mathematics in the junior and senior high schools.
3. Add an additional period of science or mathematics where necessary to the program of a highly qualified teacher and compensate him on a pro-rata basis.
4. Provide more laboratory assistants for assignment to senior high schools and to junior high schools.
5. Better supervision of science teaching at all levels. More time for supervision should be permitted each chairman to take care of the increased load.
6. All Board of Education in-service training should be carefully planned, subsidized and supervised. Supervisors and competent teachers giving these courses should be compensated. A special fund should be established for this purpose.
7. Provide summer employment for science and mathematics teachers and for interested students through the co-operation of industry (I-E Committee).
8. Provide television reception for all schools and provide model lessons in science as useful in-service training. Wider use of radio and television would bring important scientific lessons to the attention of pupils.
9. Improve and extend the science program in the elementary schools.
10. Improve and extend the science program in the junior high schools.

THIRTY-FIVE YEARS AGO

Comment on the Journal of February, 1922

The *Journal* for March, 1922, might vell be called a "Shawinigan num-ıer" since its two principal papers vere "The Generation of Steam by ˡlectricity", by F. T. Kaelin, .M.E.I.C., chief engineer of the hawinigan Water & Power Co., and The New 41,000 h.p. Unit at hawinigan Falls", by Julian C. mith, M.E.I.C., the company's presi-ent.

Mr. Kaelin's paper appears to have ›een the first description of the lectric boiler which bears his ame. This had some novel features, hough in the main it followed prece-lents set in the design and construc-ion of the 300-odd electric boilers hen in use in Italy, Switzerland, weden and France. Mr. Kaelin was irmly convinced that his boiler would ill a useful place in industry. "One f the cheapest ways of (utilizing lle electric current) is to produce team, which in most cases can be sed in conjunction with other steam enerating apparatus and where a ystem of piping for the purpose of eating or using steam for manufac-uring purposes already exists . . . t was shown by an investigation nade lately that the saving of coal luring the fifty-two Sundays and hree holidays (shut down time of a ›ulp mill) would easily pay for the nstallation of the (electric) steam enerator in less than one year."

Several of Mr. Kaelin's boilers had lready been built when this paper vas written, including one rated at 8,000 kw. and 6,600 v. and produc-ng up to 60,000 lb. of steam at 135 b. gauge pressure per hour. Two 5,000 kw. generators were also ınder construction. A good many of hese boilers were built and in gen-ral they seem to have met the laims made for them.

The new turbine and generator at hawinigan Falls were notable hiefly for their size. Compared to nodern units, 41,000 h.p. does not trike one as very big, but by the tandards of the time it was enorm-ous; 52,000 h.p. was the largest unit hen in use, though the Hydro-Elec-ric Power Commission of Ontario was onsidering larger ones for its Queen-ton-Chippewa development. The original 1903 turbines at Shawinigan Falls were of 6,000 h.p., the biggest that could then be had; the 1910 units used 18,500 h.p. wheels. Both were of the horizontal shaft type, but this new 1922 unit was a vertical one. Between 1910 and 1922 the turbine makers had developed reliable thrust bearings for heavy loads, making vertical turbines practicable.

Perhaps the most eye catching feature of the 1922 Shawinigan development was the giant Johnson-Larner valve in the penstock just back of the turbine, the largest built up to that time. It was about 23 ft. in diameter and 27 ft. long and weighed 150 tons.

Business and Research

Business was not too good in 1922. Prices were high and going up, leading, among other things to wage increase demands and consequent frequent strikes and much labour unrest. It seems to take a crisis such as this to get most engineers to thinking along economic lines. H. A. Goldman, A.M.E.I.C., of Toronto, writes in this *Journal* of "The Rise and Fall of Prices". He concluded that engineers must use their talents to analyze and control economic conditions so far as possible if we were to avoid trouble in future. He proposed that the Toronto Branch, to which his paper was addressed, should follow the time honoured practice — appoint a committee to consider the matter.

The National Research Council of which R. A. Ross, M.E.I.C., was then chairman, persuaded this *Journal* to list a few of its problems. Some are still problems, as their titles show — wheat rust; diet of black foxes (!); uses for helium; national fuel supply; utilization of lignite and of peat; utilization of low grade iron ore; and disposal of saw mill and pulp mill waste and of straw.

Institute Affairs

Secretaries of the eastern branches of the Institute, twelve in all, met in Montreal in January, 1922. As reported in the *Journal*, they discussed uniform bylaws, publicity, programs and finances, but without coming to any positive conclusions, save that they did ask Council to arrange for the preparation of uniform bylaws.

Somebody gathered a mass of personals for this *Journal*, four solid pages of them, a step in the right direction. Although this writer was reasonably active in Institute affairs at that time, he must confess that he can find only six names among all those mentioned that mean anything at all to him. *Sic transit gloria mundi!*

According to this *Journal* the Vancouver Branch was promoting the formation of "a general engineering council composed of delegates from existing organizatio ıs, to function when concerted action in the interests of all engineers is needed." It was also arguing with the city authorities over an annual tax of $25 just imposed on every engineer in private practice in the city. Naturally, engineers objected to this tax, as did doctors, dentists, lawyers, chartered accountants and other professional men subject to it. The Winnipeg Branch was also getting set to object to a proposed provincial income tax and to the tax proposals which would affect engineers.

There were forty applicants for admission to membership and twenty-one for promotion to a higher grade. Fifteen of these sixty-one are still members of the Institute.

R.DEL.F.

WORLD POWER CONFERENCE

The Transactions of the Fifth World Power Conference held in Vienna in June, 1956, will be published shortly. The theme of the Conference was "World energy resources in the light of recent technical and economic developments" and the twenty volumes of the Transactions contain, in either German, French or English, according to the choice of the author, all the 276 papers presented. They may be ordered from the Canadian Committee of the World Power Conference, T. M. Patterson, M.E.I.C., Room 500, 150 Wellington Street, Ottawa 4, Ont. The prepublication price is 3500 Austrian sch. (approximately $135.00) plus carriage. The price after publication is 3700 Austrian sch. plus carriage. In either case a discount of 20% is allowed when the order is placed through the National Committee.

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

QUEBEC

Decisions of Council

A technique currently used in Ontario by T. C. Keefer, Field Secretary of the Ontario Association, will be carried out in our own province under the responsibility of B. R. Lachapelle, Engineers' Service Officer. This technique is intended to help the Corporation increase its effectiveness in influencing the remuneration of engineers.

Bursary for Sherbrooke

Quebec's newest university, Sherbrooke University, has a school of engineering, providing the first three years of the required course. It now contemplates offering the last two years, in the not too distant future.

Council will do everything it can to assist this young university. It has decided among other things to grant a deserving student of Sherbrooke University a bursary of two hundred dollars, such as is being offered at McGill, Ecole Polytechnique and Laval.

Letter to a Mayor

The following is a letter sent recently by the General Secretary to the Mayor of a Quebec municipality.

Dear Mr. Mayor,

We understand that you are attempting to have a group of consulting engineers enter into competitive bidding for their professional services. You are asking that each of these firms of consultants stipulate in advance what their professional fees would amount to in rendering your municipality engineering services for a preliminary study of a water work and sewage disposal system.

You will readily appreciate that it is not possible for a professional man to account in advance for the time he will have to devote to his client. Hence, it is not possible to establish the exact amount of his fees in advance. These will vary with the amount of work involved and its difficulty which must be taken into consideration when the statement of fees is computed in accordance with the By-Laws governing the practice of our profession.

As for the practice of competitive bidding for professional services which your Council would follow by looking for the cheapest services they can get, it is an entirely unethical and unprofessional method which is not tolerated in any of the professions. It is quite detrimental to the public itself. That is why the Corporation of Professional Engineers of Quebec is forbidding this procedure.

Consequently, we have advised all consulting engineers from whom you have requested bids that the Code of Ethics and the Tariff of Minimum Fees of the Corporation of Professional Engineers of Quebec does not allow them to comply with your request.

May I stress that professional services should be retained on the basis of competence, integrity and accomplishment. These are the significant criteria in the selection of any professional man, be he a physician, a lawyer or an engineer.

Yours very truly,

Pierre Bournival,
General Secretary.

Speech Workshop

John D. Richards, was selected as the student who showed the most progress in the fall session of the speech workshop. On January 14, Mr. Richards and the nineteen other members of the class delivered their graduation speeches and received certificates in the auditorium of Ecole Polytechnique.

On the following Monday, the winter session of the workshop got under way with an enrolment of nineteen professional engineers. V. G. Baker continues to act as instructor.

ONTARIO

Annual Meeting

More than 1000 members of the Association of Professional Engineers of Ontario gathered at the Royal York Hotel, Toronto, on January 26, 1957, to hear and discuss the policies and reports of Association activities during the past year. In his presidential address, retiring president Merritt W. Hotchkin, of Kirkland Lake, Ont., outlined the growth of the profession in Ontario from a membership of 3000 in 1945 to its present enrolment of 15,500. He described the Association as "a power in the affairs of Canada" and added that it was the duty of the professional man to contribute his specialized knowledge for the general welfare whenever the occasion arose.

He also referred to a renewal of the joint professional engineer-architect committee and said he looked forward to co-operation and valuable discussion between the two groups.

Educational Stand

Declaring that "This Association should be prepared to be outspoken on matters of education," Mr. Hotchkin remarked on the establishment of new engineering courses at the University of Western Ontario, Ottawa University, and Assumption College, and singled out "the completely new type of school for Canada which is being studied by Waterloo College". Noting the shortage of secondary school teachers, he added that the situation had not yet become as severe in Canada as in the United States, where no physics courses are taught in 60 per cent of high schools, due to a shortage of teachers.

Report on Gerontology

Among those reports presented at the annual meeting was an announcement to the effect that the first Ontario Conference on Aging will take place in Toronto, from May 31 to June 3, 1957. The conference will bring together authorities and interested representatives from the many fields concerned with the problems of the aged, such as labor, industry, education, the professions, social services and churches.

Council Discusses Technician

The Executive Council of the Association, meeting on January 24, 1957, prior to the annual meeting, has approved a plan to establish standards of qualification for engineering technicians and also set up a system of voluntary registration for them as such.

The engineering technicians would be examined by the Association and classified in four grades which would be determined by their educational qualifications and technical experience.

The Association points out that at present there is no registering body for engineering technicians in the province, and that such a system would be of great value both to industry and to the technician.

The A.P.E.O. emphasized that this move did not mean that engineering technicians would become members of the Association, but pointed out that such technicians by self-improvement, further education and experience, advance through the various stages and finally secure registration as members of the Association.

Submits Report

A report, prepared by a special committee studying the engineering technician problem was tabled at the meeting.

The committee, headed by Dr. George B. Langford, of the University of Toronto, noted in its report that: engineering technicians were invaluable assistants to professional engineers in taking over some of the non-professional duties of an engineer, and allowing the latter to carry out full-time professional work; that there was a need for a rapid increase in the number of such technicians to keep pace with the demand for their services, that many industries now are employing four or more technicians for every professional engineer; and that there was evidence within the engineering technician body of a desire for recognition and the establishment of accepted standards of technical qualifications.

Dr. Langford said there was an urgent need for such a system of registration for technicians. It would, he added, encourage them to progress, and would also serve industry as a method of defining the upgrading of their technical employees, employment requirements and salary structure.

Dr. Lord — Maths Are Basis

The Association of Professional Engineers of Ontario is concerned with "a very real threat to the profession" in the form of a decline in the teaching standards of Ontario's high school mathematics and science teachers.

The Professional Engineers' salary survey, compiled by the Association during 1956, attracted wide interest during the annual meeting. Shown here left to right are: W. E. Rose and P. S. Reavill, both of Sarnia; E. E. MacPhail, Toronto; and J. Klassen, Ottawa.

In referring to mathematics as "the basis for engineering", Dr. G. Ross Lord, head of the department of mechanical engineering of the University of Toronto, told the Association's executive council here today that "one-half of those graduating from the Ontario College of Education who could be teaching mathematics in the high schools, have only their Grade XIII maths".

It was pointed out at the meeting that a recent survey of Ontario's high schools showed that of 630 mathematics and science teachers, 400 had not taken maths and science courses beyond Grade XIII.

"They're not taking the courses at university because they think they'll fail them," said Dr. Lord, "with the result that the pupils they are teaching are not getting sufficient grounding in these subjects." But he conceded that the situation was worse in the United States where high school students have an option on taking maths and sciences. Less than 25 per cent of the students are taking these subjects.

"How does the U.S. expect to keep pace in the engineering race with Russia when there aren't enough students taking maths to continue on into university?" Dr. Lord asked.

He said the engineering profession in Ontario had to take stock of this alarming situation and do something to improve it.

"It's the educational background that makes the profession," he added, pointing out that there were signs that students were losing respect for their teachers as authorities in maths and sciences.

Brigadier C. D. Quilliam, long-time soldier, and for a number of years since World War II, chief Middle East correspondent of the London Times, presented a first-hand picture of Middle East problems in his address to the annual luncheon meeting of the Ontario Association. Flanking Brig. Quilliam are, left to right: John H. Fox, Toronto, Association president; C. T. Carson, Walkerville, first vice-president, and L. F. Grant, Toronto, Field Secretary of the Institute.

Would End Discrimination

The Executive Council of the Association has called upon the Department of National Defence to end its discrimination of professional engineers who are serving in the armed services, particularly in the Army.

The Council asked that professional engineers in the Army be accorded the same financial recognition currently received by medical and dental officers.

Medical and dental officers receive $60.00 per month professional pay up to the rank of colonel. There is no provision for professional pay to Army engineers.

The A.P.E.O. also feels that there should be more scope in engineering projects for the Army professional engineers.

Engineers in the News

S. T. Bieniada has left the Department of Highways of Ontario and has moved from Toronto to Ottawa, where he is employed by the Department of National Defence (Army) as a structural engineer in the design division of the structures section.

George C. Chernish has moved from Niagara Falls, Ont. to Santa Ana, Calif., where he holds the post of chief engineer with B. J. Electronics, Borg-Warner Corporation.

Peter A. Livingston has left the employ of Abitibi Power and Paper Co. Ltd., in Toronto, and is with the K.V.P. Company Ltd., at Espanola, Ont.

S. G. Petursson, is sales equipment supervisor with Dewey and Almy Chemical Company of Canada Ltd, 1244 Dufferin Street, Toronto. Mr. Petursson who graduated in mechanical engineering from the University of Manitoba in 1951, was earlier on the engineering staff of the John Inglis Co. Ltd., of Toronto.

W. H. Bates, of the Canadian Westinghouse Co. Ltd., has been transferred from Ottawa to the head office of the company in Hamilton, where he is with the electronics division, Hamilton Plant No. 2, Longwood Road.

S. M. Peterkin & Associates, Ltd., consulting engineers, have moved to 21 Sultan Street, Toronto from the previous address: 116 Bloor Street West, in the same city.

W. E. Emmerson has joined the air conditioning division of Canadian Ice Machine Co. Ltd., 95 Villiers St. Toronto. Mr. Emmerson was formerly division engineer in the new work division of the Underwriters' Laboratories of Canada, Toronto.

A. N. Campbell, of the Du Pont Company of Canada Ltd., has been transferred from Montreal, Que., to Kingston, Ont., where he has assumed the responsibilities as assistant works manager of the company's nylon plant in that city.

F. R. Thompson, has moved from Asbestos, Que., to Trail, B.C. where he is with the Consolidated Mining and Smelting Company of Canada Ltd., Mr. Thompson was formerly employed by Canadian Johns Manville Coompany, Ltd. at Asbestos.

C. S. LeClair has recently joined Peacock Bros. Ltd., in Montreal, as chief engineer of the company's new project and development department. Mr. Le Clair came to Canada from England in 1951 and until taking over his new post practiced in Toronto a a consulting engineer.

J. C. R. Punchard, manager of the Belleville Plant of the Northern Electric Co. Ltd., has been appointed as Canadian member of the Awards Committee of the Inistute of Radio Engineers.

Marlin D. Smith, has left Sarnia, Ont. where he was with the Canadian Oil Refineries Ltd., and is now on the Engineering Staff of Lago Oil & Transport Co. Ltd., Aruba, Netherlands Antilles.

Robert G. Martinek has been appointed chief engineer of the Eclipse Fuel Engineering Co. of Canada Ltd., manufacturers of industrial process heating equipment at Toronto.

Mr. Martinek graduated in engineering from the University of Vienna in 1939 and has been in Canada since 1943. He joined the staff of Eclipse in 1954.

H. G. McHaffie, general manager of the British Thomson-Houston Co. (Canada) Ltd., has announced the purchase by the company of new premises at 766 King Street West, Toronto, where the firm's head office is located. An office has also been opened in Vancouver, B.C., at 326 West Pender Street.

William J. R. Thomson, of the Ontario Department of Highways has moved from Owen Sound to Ottawa where he is assistant engineer with the department.

R. C. Fraser, has left the employ of the Corporation of the City of Hamilton to become a design engineer with C. C. Parker & Associates, Hamilton, Ont.

MANITOBA

Election of Officers

At the thirty-seventh annual meeting of the Association of Professional Engineers of Manitoba, held recently, the following members were elected to office: N. S. Bubbis, President; L. A. Bateman, vice-president, and C. S. Landon, secretary-treasurer.

Retiring President Interviewed

Retiring president of the Association, Professor Jack Hoogstraten, in an interview declared that more attention must be paid the developing high school student displaying a mechanical aptitude and good marks in mathematics and science.

Dr. Hoogstraten advocated that the need for engineers be stressed at an earlier period in the student's school life, at least at the high school level. Although Russia is now turning out more engineers than North America, Canada would be wise in producing sufficient engineers to coincide with her rapidly expanding growth and economy.

Professor Tweedie Guest Speaker

Professor A. S. R. Tweedie, in addressing the annual meeting, dealt with the problem of future enrolment of engineering students in universities and colleges across the country.

With the infants of the early forties now at university entrance level, it was felt that if the percentage increase remains constant, by 1970 enrolment will have climbed 85 per cent above the present record. As no Canadian university is equipped to handle this flood, a building program must be undertaken in the next two or three years. With no ready reserves in cash or staff, universities are unable to expand their staff or facilities.

The Canada Council

Professor Tweedie felt that the Canada Council was a modest step in the right direction. All Canadian provinces are seeking to augment their support of the universities, and are predicting a marked increase in support of higher education.

The university instructor is beginning to realize that he is now in a buyer's market, and that he is in a position where he is much in demand, and at a higher salary. The University of Toronto requires an additional staff of 400 in the next decade. Dr. Tweedie stressed that just where they are to be found is difficult to ascertain unless it is by dangling the everpresent cheque book.

He added that while building of a non-residential nature is twenty-three times greater than in the past decade and construction for centres of higher education increased only four times, Canada cannot be accused of squandering new found wealth on higher education.

BRITISH COLUMBIA

Engineers in the News

R. C. B. Henderson, formerly with the Aluminum Company of Canada at Kitimat, B.C., is now engaged on a large hydro-electric project in East Pakistan.

Now an employee of the International Engineering Company Inc., of San Francisco, Mr. Henderson is senior office engineer on the firm's Karnafuli hydro-electric project in the Chittagong Hill Tracts in East Pakistan. Consisting of an 1800 foot impervious rolled fill earth dam, a large spillway capable of discharging nearly 600,000 cubic feet of water per second and a powerhouse with an estimated initial capacity of 107,000 h.p., it is roughly equivalent to the output of the B.C. Electric's Buntzen development.

Mr. Henderson expects to be engaged on the project for two years.

F. R. R. Jones, until recently genera[l] superintendent, MacIntyre Development Tahawus, New York, has resigned fro[m] the National Lead Company to accep[t] the position of mine manager, Stanroc[k] Uranium Mines Ltd., Toronto.

P. G. Wolstenholme has sent word tha[t] he is now assistant construction manage[r] with Sprostons (Jamaica) Ltd., and i[s] engaged in work on the extensio[n] to the aluminum ore plant of Alumin[a] (Jamaica) Ltd.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

C. A. Waterous, M.E.I.C., retired vice-president and general manager of the firm of Waterous Limited, a Brantford, Ont., company, died on December 7, 1956, in that city.

A native of Brantford, he was born on April 6, 1877. He attended Montreal high schools and graduated from McGill University with a degree in mechanical engineering in 1898. He was at that time the youngest man ever to be admitted to a B.Sc. degree at that college. Returning to his home that year he joined the family firm of Waterous Limited. From 1925 to 1935, a period of notable expansion for the company, particularly in the manufacturing of pulp and paper mill machinery, he was vice-president and general manager.

Mr. Waterous retired from public office in 1949.

A member of the Board of Water Commissioners of Brantford he served that body almost continually from 1917 to 1944.

Mr. Waterous was a member of the American Society of Mechanical Engineers and was awarded the "Gold Card" of that organization. He was a charter member of the Grand Valley Group of professional engineers. He was also a member of the Association of Professional Engineers of Ontario.

He joined the Institute as a Student member in 1898, became an Associate member in 1903, and transferred to Member in 1909. He attained Life membership in 1947.

Frederick William Paulin, M.E.I.C., president and owner of the Canadian Engineering and Contracting Company Limited, Hamilton, Ont., died in hospital at Hamilton on January 18, 1957.

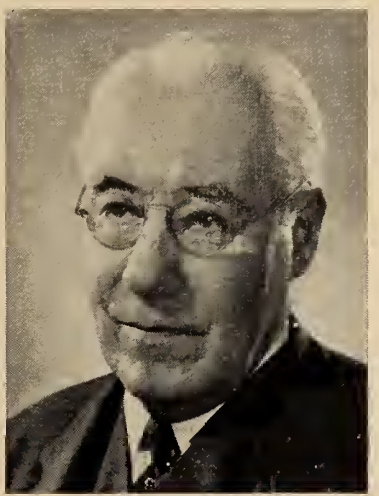
Mr. Paulin was born at Arthur, Ont. on September 16, 1882. He followed his engineerinfg studies at Toronto University, graduating in 1907 from the School of Practical Science.

Some of his early engineering experience gained as an Ontario Land Surveyor he also took part in laying the Great West and T. and N.O. Railway, now a part of the Canadian National Railway System. He was employed as City engineer at Niagara Falls in the early days and was engaged in the installation of the Whirlpool Rapids Cable Car. A founder of the Canadian Engineering and Contracting Company Limited in 1914, he moved to Hamilton at that time.

During the years of the depression he transferred his activities to Buffalo, N.Y., and formed the F. W. Paulin Contracting Company Limited. Later he was appointed president of the District Improvement Corporation and of the Great Lakes Concrete Pipe Company Inc. of Buffalo. He had the signal honour of being the first Canadian elected president of the American Concrete Pipe Association. This body is responsible for the specifications under which concrete pipe is manufactured.

While resident of the United States Mr. Paulin was elected to the boards of several companies, including General Plastic Inc.

He was for a number of years a director of the Concrete Pipe Company.



F. W. Paulin, M.E.I.C.

Largely responsible for organizing the Consolidated Specialties Limited, now known as John Dickinson Limited, he was also a founder of Design-Craft Limited, at Toronto. He was chairman of the board of that company which for eight successive years built the Canadian International Trade Fair.

In recent years Mr. Paulin served the City of Hamilton as chairman of the Adjustment Committee.

He joined the Institute as a Student member in 1907, transferred to Associate Member in 1913, and became a Member in 1922. He attained Life membership in 1948.

John Russell Montague, M.E.I.C., director of engineering for eight years for the Hydro-Electric Power Commission of Ontario died at Toronto on January 9, 1957. Recently retired from the above position he had remained with the commission as a consultant.

Born at Niagara Falls, Ont., on March 25, 1891, he studied engineering at the University of Toronto and obtained a B.A.Sc. degree in 1914.

Responsible in some measure for the design of almost every hydro power plant in the province, including the Sir Adam Beck No. 2 development at Niagara Falls Mr. Montague's association with the Hydro Electric Commission dates back to 1918, a period of thirty-eight years.

He received his early engineering experience with the Laurentian Power Company, Beaupre, Que., the International Waterways Commission, in the Niagara area, and the old Ontario Power Company at Niagara Falls. He also served two years as superintendent of construction for the Raymond Concrete Pile Company of Montreal and New York. He joined the Ontario Hydro as a design engineer in 1918 and worked first at Niagara, before moving to Toronto.

Besides planning and building complete power plants, Mr. Montague was responsible for investigation of numerous power and storage sites, and river diversions.

In his capacity as director of engineering Mr. Montague last year travelled to England to recruit engineers for the Hydro Electric Power Commission.

He was to have become president of W. S. Atkins and Associates, consulting engineering firm, on his retirement.

A member of the Association of Professional Engineers of Ontario he was their 1955 choice as president. Also a member of the American Institute of Electrical Engineers he was an executive officer of the Electric Club of Toronto.

Mr. Montague joined the Institute in 1918 as an Associate Member and was transferred to Membership in 1940. He attained Life membership in 1954.

Leonard H. Robinson, M.E.I.C., retired division engineer with the Canadian National Railways, died October 9, 1956, at Ganonoque, Que.

Born at Brockville, September 4, 1878, he attended the School of Practical Science, Toronto, graduating in civil engineering in 1904.

His engineering career, which was spent in railroading began in 1904 when he went into exploration and survey work for the National Transcontinental Railway in Northern Quebec, Ontario and Manitoba. Transitman for locating engineers Frank Moberly and W. H. D. Armstrong in District D, he was later in 1907 transferred to a post as resident engineer on Residency 12, east of Superior Junction, and also served at Sioux Lookout. Promoted to locating engineer in 1913, and to division engineer maintenance of way six years later, he held the post until 1926, residing at Bridgewater, N.S. and Campbellton, N.B. From 1933 to his retirement in 1940 he was division engineer with the C.N.R. at Halifax.

A man of diverse interests it is interesting to record that he rowed for the Brockville Rowing Club in a "four" that won the Canadian Championship; that he played in a symphony orchestra and was an excellent boxer, fighting with "Gentleman" Jim Corbett. Accredited as one of the finest canoe men in the North Country he shot the Drowning Rapids on the Quinzes River carrying two bodies in the canoe, rather than carry them over the portage. He was the first to master the rapids.

He is known to have discovered

Noranda mines, long before it was staked. He did not possess a license at that time.

Mr. Robinson also enjoyed writing poetry in later years. Several of these were published.

Mr. Robinson joined the Institute in 1909, transferred to member in 1927 and attained Life Membership in 1940. Active in the affairs of the Institute he was a Councillor representing the Halifax Branch in 1932 and 1933.

Kenneth George Ross, M.E.I.C., retired partner in the firm of Lang and Ross, Sault Ste. Marie, Ont., died at his home in that city on December 26, 1955.

Mr. Ross was born in Toronto on August 2, 1884, and followed his studies at Upper Canada College and at the School of Practical Science, University of Toronto. He graduated in engineering in 1906.

One of the pioneer Land Surveyors of Ontario he worked in Manitoba and Northern Ontario following graduation, and carried on the work of land surveying for a number of years. He moved to Sault Ste. Marie in 1910.

Overseas with the Canadian Army during World War 1 with the 227th battalion, he was returned to Canada in 1918 with the rank of major and resumed his work as land surveyor. About that time he also went into private practice with the late John L. Lang, M.E.I.C., and became vice-president of the firm, named Ross and Lang. They were general engineering contractors, specializing in hydro-electric developments and transmission lines. Instrumental in the building of power projects at Algoma, he also directed the building of the first dams and powerhouses to harness the Montreal and Michipicoten Rivers.

Mr. Ross became a director of the Great Lakes Power Corporation and the International Transit Company. He retired from active engineering practice in 1953. He was for many years a member of the Sault Ste. Marie town planning board.

He was also an authority on Ojibway folklore, history and habits.

He was also a member of the Newcomen Society.

Mr. Ross joined the Institute in 1919 in the status of Associate Member. He transferred to Member in 1932, and attained Life membership in 1955.

James Norman Stanley, M.E.I.C., retired Ontario engineer died at his home in Toronto on January 7, 1957.

Mr. Stanley was born at Ruselltown, Que., on February 15, 1879. He was educated at Queen's University, and obtained a Master of Arts degree in 1901, followed by B.Sc. in 1908.

Working with various companies intermittently in the years between his two degrees, he was associated with the St. Maurice Valley Railway in 1905 and the following year signed on with the C.P.R. In 1910 employed by another company he worked on a project for the Ontario Hydro Electric Commission from Ingersoll to St. Thomas. In 1911 he joined the Shawinigan Water and Power Company Limited as a divisional engineer on transmission lines.

During his career Mr. Stanley was also resident engineer and superintendent of construction at the Hydro-Electric Power Commission of Ontario's Nipigon power development. He was also superintendent of construction at Decew Falls power development.

Mr. Stanley joined the Institute as a Student member in 1908, transferred to Associate Member in 1912 and became a Member in 1940.

Samuel W. Andrews, M.E.I.C., president and director of H. G. Acres and Company Limited, Niagara Falls, Ont., died on December 31, 1956 at Niagara Falls.

Born and educated in the United States, he was a native of South Dakota. He was born at the town of Lead on September 24, 1890. Mr. Andrews graduated with a degree in mechanical engineering at Cornell University in 1912 and from that year until 1917 worked on railway electrification in the western United States. In 1917 he joined the Hydro-Electric Power Commission of Ontario. He was assistant plant engineer and then plant engineer from 1918 to 1924 during the construction of Queenston-Chippawa Development, In 1924 he joined the staff of H. G. Acres and Company as a mechanical engineer. Appointed chief engineer of the firm in 1934, he rose to the position of president in 1945.

Among his many contributions to the development of engineering works in Canada he is to be remembered for his part in the hydro-electric developments at Grand Falls, N.B.; the Outardes Development of the Ontario Paper Company; the Shipshaw Development of the Aluminum Company of Canada; the Campbell River development of the B.C. Power Commission; the Pine Falls development in Manitoba and the Beauharnois for Hydro-Quebec.

Mr. Andrews joined the Institute in 1946.

Frederick Ernest Estlin, M.E.I.C., of the Canadian General Electric Company Limited, Regina, Sask. died on December 11, 1956, in that city.

Born on the prairies, at Melita, Man., on January 7, 1903, Mr. Estlin was a 1925 graduate of the University of Manitoba in electrical engineering. He entered the Canadian General Electric Company Limited test department at Peterborough, Ont., on obtaining his degree and remained there for a year. In 1926 he returned to Winnipeg, and late that year was named industrial control specialist with C.G.E. A sales engineer for the company at Regina, Sask., in 1938, he was in 1939 appointed manager and sales engineer and held that position until the time of his death.

Ardent in his support of the Saskatchewan Branch of the Institute in all its activities, Mr. Estlin served as a member of the executive committee in 1943 and 1944; as vice-chairman in 1945 and chairman the following term.

In 1949-50 he was elected councillor of the Institute.

Mr. Estlin joined the Institute in 1926 as a Student Member, transferred to Associate Member in 1938 and became a Member in 1940.

Ralph Allison Hendry, M.E.I.C., former resident engineer with the Department of Highways, for the Province of Nova Scotia, died in Windsor, N.S., on October 12, 1956.

Born at Halifax, N.S., on January 29, 1893, he studied engineering with a private tutor and with his father, William Almon Hendry, chief engineer of the Department of Highways of Nova Scotia, in the early twenties. Grandson of W. A. Hendry, chief Crown Surveyor of Nova Scotia, he was a great grandchild of Titus Smith, who made the first survey of the province in 1801.

Mr. Hendry served overseas with the First Canadian Division in World War I, returned to Canada in 1919 and was first employed with the Department of Highways in the early twenties. He also spent some time as a Provincial Land Surveyor and worked with the Mersey Paper Company Limited in the timber estimating and surveying field for a short time at the end of the decade. From 1935 to 1941 he was associated with the Department of Highways as a resident engineer and played an important part in the reconstruction of the Nova Scotia highway system.

During World War II Mr. Hendry was associated with the Department of National Defence, Naval Services, as a civilian engineer on airport construction.

He joined the Institute in 1940.

Howard Arthur Roach, JR.E.I.C., field engineer with the St. Lawrence Seaway Authority was the victim of a drowning accident at Montreal, on January 15, 1957.

Mr. Roach was born at River Hebert, N.S., on December 17, 1922. He attended Queen's University and received a B.Sc. degree in civil engineering in 1950, following service overseas with the R.C.A.F. in World War II. He was employed with the Ontario Department of Highways, Toronto and with the Ford Motor Company of Canada Limited at Windsor, Ont., before joining the Department of Transport, Special Project Branch, in 1953, to work on the St. Lawrence Seaway project. When he met his untimely death, Mr. Roach was senior assistant engineer at Ville Jacques Cartier lock construction area near St. Lambert, Que.

He joined the Institute as a Student Member in 1950 and transferred to Junior in 1952.

Personals

News of the Personal Activities of Members of the Institute.

Prof. C. V. Christie, M.E.I.C., for many years head of the department of electrical engineering at McGill University was recently presented with an honorary membership in the Canadian Electrical Association. He is the third person to have been so honoured.

After a career with the University dating to 1906, the year of his graduation from that college, Prof. Christie retired as head of the department in 1947 but continued as professor in electrical engineering until 1952, when he became professor emeritus.

The following year he went into private practice as a consulting engineer at Westmount, Que.

He has always played an active part in the work of engineering societies and has held office in the Institute, both with the Montreal Branch and as a councillor. He was also vice-president of the American Institute of Electrical Engineers during the thirties.

W. Elwood MacDonald, M.E.I.C., Commissioner of Water Works for the City of Ottawa was recently honoured in receiving the "Citizen of the Year" award presented by the Ottawa Press Club.

In 1952 Mr. MacDonald was winner of the Fuller Award of the American Water Works Association (Canadian section) for his distinguished service in the water supply field.

Mr. MacDonald, who received the appointment he now holds with the City of Ottawa, in 1950, first entered the service of the Corporation of Ottawa in 1912 and has devoted his entire career to the water works field.

W. E. MacDonald, M.E.I.C.

Frederic Alport, M.E.I.C., consulting engineer of Orillia, Ont., won a total of 2950 votes as newly elected candidate in the Orillia, Ont., Water, Light and Power Commission election contest, recently held in that Ontario municipality.

A native of Orillia, Mr. Alport has been carrying on private practice there since 1947, after more than thirty years in engineering work across Canada. He specializes in harbour works, tunnels, foundations, water supply and sewage disposal.

Mr. Alport served on the Council of the Institute in 1954-55, representing the Huronia Branch. Largely responsible for the founding of the Branch in 1953 he was its first chairman.

In 1946 Mr. Alport was awarded the O.B.E.

In fairly recent times he has been associated with a number of very large projects. The Department of National Defence employed Mr. Alport as a consulting engineer to the Director of Naval Technical Service. He was on loan from the Public Works Department, which later stationed him in Ottawa. There he acted as representative of the Department on the Lake of the Woods Control Board, and has handled administrative work of the Northwest Territories, including the Yellowknife projects. He was a member of the special committee of three appointed by the Minister of Transport to study and report on the St. Lawrence deep water channel from Montreal to the sea.

A.V.M. A. L. James, M.E.I.C.

F. Alport, M.E.I.C.

Air Vice-Marshal A. L. James, C.B.E., C.D., M.E.I.C., has been appointed president of Bristol Aero Engines, Limited, Montreal North, and Bristol Aero Engines (Western) Limited, Vancouver. He has also been named a director of the latter company. Air Vice Marshal James joined Bristol Aero Engines Limited in 1954, becoming vice-president and general manager of the company at the time.

Long known in aviation circles, he joined the R.C.A.F. in 1924. He has held many senior appointments in the Air Force including that of Air Officer Commanding Air Defence Command. In that post he was responsible from 1952 to 1954 for the Canadian side of the planning and implementation of an arrangement by which the air defence systems of Canada and the United States operate as a team in the event of an emergency.

As Air Member for the Technical Services at R.C.A.F. headquarters between 1946 and 1951, he became well acquainted with the British and Canadian aircraft industries.

William L. Pugh, M.E.I.C., chief engineer of the Aluminum Company of Canada Limited, for the past ten years has recently relinquished this post due to ill health. He will, however, retain his connection with the company as a consulting engineer.

While employed as chief engineer Mr. Pugh was in charge of all engineering and construction work including the large aluminum plant development at Kitimat, B.C.

Mr. Pugh joined the Aluminum Company of Canada in 1937, at Arvida, Que., as a structural engineer and carried out the design for the greater part of the expansion of the Arvida works which started at that time. He became chief engineer of the Company in 1948.

He was awarded The Keefer Medal of the Institute in 1950.

F. E. Regan, M.E.I.C., was recently named president and general manager of Bepco Canada Limited.

Mr. Regan has been with Bepco since the inception of the company in 1933. He was originally Ontario manager and latterly vice-president and assistant general manager when he moved to the head office in Montreal last year.

W. B. Pennock, M.E.I.C., of Ottawa has announced that the consulting engineering practice of the Pennock Engineering Company in that city will now be conducted by Pennock Canadian-British Limited.

The new company was formed in 1956 with W. B. Pennock as president. One of the directors of this firm is T. C. Main, M.E.I.C., senior partner of Canadian British Engineering Consultants of Toronto, Halifax and Vancouver. He was well known as first general manager of 'Ducks Unlimited'.

Mr. Pennock is chairman of the Ottawa Branch of the Institute.

A. W. F. McQueen, M.E.I.C., former vice-president of the H. G. Acres Company Limited, Niagara Falls, Ont., has been appointed president of the firm.

A graduate of the University of Toronto, class of 1923, he worked as an assistant engineer with the Ontario Hydro from 1923 to 1927. He joined the Acres Company at that time and in 1938 was appointed hydraulics engineer. He became vice-president and general manager in 1953.

Mr. McQueen is a councillor representing civil engineering in the Association of Professional Engineers of Ontario and a director of the Fluor Corporation of Canada, Canadian Overseas Projects Limited, and the Niagara Falls Club.

H. E. Barnett, M.E.I.C., who formerly held the appointment of vice-president and chief engineer of H. G. Acres Company Limited has been named executive vice-president and general manager of the company.

A maritimer and graduate of the University of New Brunswick, Mr. Barnett joined the Acres organization in 1925 and has been employed with the firm since that time except for a period in the thirties when he worked with the Dominion Construction Corporation, at Toronto.

Dr. W. H. Gauvin, M.E.I.C., associate professor of chemical engineering at McGill University, and consultant to the Pulp and Paper Research Institute of Canada, has been named head of the latter organization's newly-formed chemical engineering division. Dr. Gauvin will continue to lecture and to supervise those McGill University Ph.D. candidates in chemical engineering who are at work on fundamentals of interest to the pulp and paper industry, and who are thereby identified with the Pulp and Paper Institute. This arrangement, like those of long standing in the fields of wood chemistry and the physical chemistry of fibres, will therefore represent not only additional strength to the Institute in a basic research discipline, but also additional industrial support to the University for graduate work.

Dr. Gauvin, a 1941 graduate in chemical engineering from McGill University was awarded a Ph.D. degree in physical chemistry from that university in 1944. Two years later he received the appoint-

Dr. W. H. Gauvin, M.E.I.C.

ment of associate professor of chemical engineering which he now holds.

Since 1950 he has been consultant to the Pulp and Paper Institute, and has worked chiefly as supervisor of Project RC-6, the "Recovery of Sulphur and Other Values from Sulphite Waste Liquor". and its outcome, the atomized suspension technique.

He has published some twenty papers on electrochemistry, spray drying and the technology of small particles.

Dr. Gauvin was in 1955 elected to the Council of the Engineering Institute, representing the Montreal Branch. He also serves on the Admissions Committee and is chairman of the Papers Committee of the Institute.

M. E. Stewart, M.E.I.C., of the Northwestern Utilities, Edmonton, has been named general manager of the company. He has served in the capacity of assistant general manager for the past nine months.

Mr. Stewart joined the staff of Northwestern Utilities in 1949, on completion of his studies in the field of Business Administration. He obtained a master of commerce degree in Business Administration from the University of Toronto in 1949.

He received his initial degree in civil engineering from the University of Alberta, class of 1947.

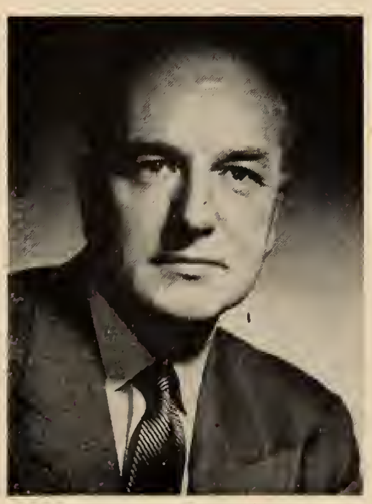
Terence J. Farrell, M.E.I.C., of Canadian Vickers Limited, has been named manager of engineering sales, Central region, with headquarters at Toronto.

Mr. Farrell, who is a graduate in engineering from Manchester College, class of 1946, began his career with Vickers-Armstrong Limited. In 1956 he was a sales engineer with Canadian Vickers Limited, at head office, Montreal.

E. T. Buchanan, M.E.I.C., formerly chief engineer of the Consolidated Paper Corporation Limited has been appointed acting division manager of the Laurentide division, at Grand'Mere, Que.

Mr. Buchanan has been assocated with the pulp and paper industry since 1935 and received his appointment as chief engineer in 1953.

Mr. Buchanan served as a Councillor



F. E. Regan, M.E.I.C.

W. B. Pennock, M.E.I.C.

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The enlarged photograph, right, shows the finished appearance of the ground and polished weld contours which resulted in complete freedom from notches.

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• PERSONALS

of the Institute, representing the St. Maurice Valley Branch in 1955. He is also a past chairman of that Branch.

Viggo Jepsen, M.E.I.C., assistant to the chief engineer at the Consolidated Paper Corporation Limited, Grand'Mere, Que., has been appointed assistant chief engineer.

Mr. Jepsen joined the organization in 1936 at Grand'Mere., a number of years after coming to this country from his native Denmark where he studied engineering.

He is a past Councillor of the Institute representing the St. Maurice Valley Branch, 1947. He also served as chairman of the Branch in 1942.

Gudmund Eriksen, M.E.I.C., has accepted a position with the Toronto consulting engineering firm of R. V. Anderson Associates. He will carry out the work of project engineer.

Mr. Eriksen has been resident in Port Arthur, Ont., for a number of years and held various appointments with the City of Port Arthur.

Mr. Eriksen is a graduate of the Kristiania Technical Institute in Oslo, Norway.

J. R. Eason, M.E.I.C., was appointed secretary-treasurer of the Saguenay Branch for the 1956-57 term.

Following graduation from the University of Saskatchewan in 1949 Mr. Eason spent two years with the Water Resources division in British Columbia, working on the Columbia River drainage basin study. Later he accepted a position in Eastern Canada with the Consolidated Paper Corporation Limited at Grand 'Mere, Que.

Since 1952 Mr. Eason has been associated with the Aluminum Company of Canada Ltd., at their Arvida Works, Que.

He also holds office as secretary-treasurer of the Saguenay Chapter of the Corporation of Professional Engineers of Quebec.

H. J. Butterhill, M.E.I.C., of the Deloro Smelting and Refining Company Limited has been appointed manager of the smelting and refining division and is responsible for operations at the Deloro works.

Previously assistant manager of cobalt operations with the firm at Delora, Ont., he has also filled such positions as chief metallurgist and chief inspector of the Aluminum Company of Canada, Arvida works.

He is a graduate of the University of Toronto, class of 1940.

W. G. Mayberry, M.E.I.C., of Babcock-Wilcox and Goldie-McCulloch Limited, Galt, Ont., until recently a development engineer with the company, has been named manager of the Pump and Turbine division of the firm.

Mr. Mayberry is a 1947 graduate of the University of Toronto in mechanical engineering.

He previously gained experience with Canadian Allis-Chalmers (1951) Limited, Montreal.

D. Laschuk, M.E.I.C., a graduate of the University of Lviv in the Ukraine, class of 1943, has accepted an appointment with the C. D. Howe Company Limited at Port Arthur, Ont.

Mr. Laschuk has been for a number of years employed with the Giant Yellowknife Gold Mines Limited, and was in 1953 a layout engineer.

John H. Redding, M.E.I.C., a 1944 graduate of the University of Cambridge in mechanical sciences is at work with H. G. Acres and Company Limited, at Gujrat West Pakistan. He is employed as a project manager at the Shadiwal Canal hydro-electric project.

A. R. Moffat, M.E.I.C., who was for the past two years at work with H. G. Acres and Company Limited, in British Columbia, has been transferred to the province of Quebec. He has been employed as resident engineer with the Acres organization on the Chute-des-Passes Power Development of the Aluminum Company of Canada on the Peribonka River, Que. While at work in British Columbia

• PERSONALS

Mr. Moffat was resident engineer on the Ladore Generating Station and Upper Campbell Lake Development of the B.C. Power Commission at Campbell River, B.C.

Mr. Moffat has been with the company since 1947 and has been engaged in many important power projects.

H. B. Tafelmacher, M.E.I.C., formerly at Montreal with the Aluminum Company of Canada Limited, has been transferred to Uruguay, where he has assumed a position as an assistant general manager for the company at Monte Video.

B. W. Anderson, M.E.I.C.

Mr. Tafelmacher is a graduate of the Federal Institute of Technology at Zurich, class of 1946 in mechanical engineering.

Blair W. Anderson, M.E.I.C., has been named general manager of the British Columbia firm of Power Machinery Limited, manufacturers of PM Chain Saws.

Mr. Anderson, a graduate of McGill University, class of 1944, has recently returned from the east where he had extensive production and management experience as assistant production manager for Canada, of the St. Regis Paper Company (Canada) Limited.

L. F. Mason-Tulby, M.E.I.C., secretary-treasurer of the Sault St. Marie Branch of the Institute for the 1956-57 term is a graduate of a South African school of engineering.

Mr. Mason-Tulby graduated in 1933 from the Witwatersrand Technical College in Johannesburg.

In Canada since 1952, he has been associated with the Armco Drainage and Metal Company at Sackville, N.B., and more recently with the Algoma Steel Corporation, at Sault Ste. Marie, Ont., where he is presently employed.

Director of the South African Branch of the Armco International Corporation from 1947 to 1952, Mr. Mason-Tulby prior to that time was in private practice. He also served in the Engineer Corps in the Middle East and North Africa during World War II.

In the opening years of his career Mr. Mason-Tulby held various positions in South African mining companies, with firms handling the importation, supply and installation of mining machinery; with a large gold mining group in design and layout work; as a design engineer with a cement company, and an assistant consulting engineer with the Bailey mining group.

G. Parrott, M.E.I.C., has accepted a post with the Sudan Mercantile Company (E) Limited at Khartoum, Sudan, Africa. His work is that of senior electrical engineer.

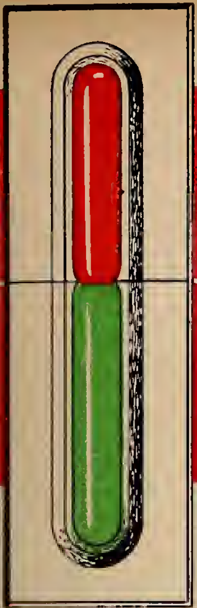
Mr. Parrott was in 1956 associated with the Canadian General Electric Company transformer works at Guelph, Ont., as a transformer and reactor designer.

He is a graduate in electrical engineering and a member of the Institution of Electrical Engineers.

W. A. Arsenault, M.E.I.C., is resident engineer for Quebec-Hydro on the Bersimis River hydro-development project, near Labrieville, Que., the completed site of hydro development, No. 1.

Mr. Arsenault was previously associated with Fraser-Brace Engineering Company, Montreal and was also resident engineer with the Rankin Newfoundland Company, at St. Lawrence, Nfld.

He is a 1937 graduate of the Nova Scotia Technical School.



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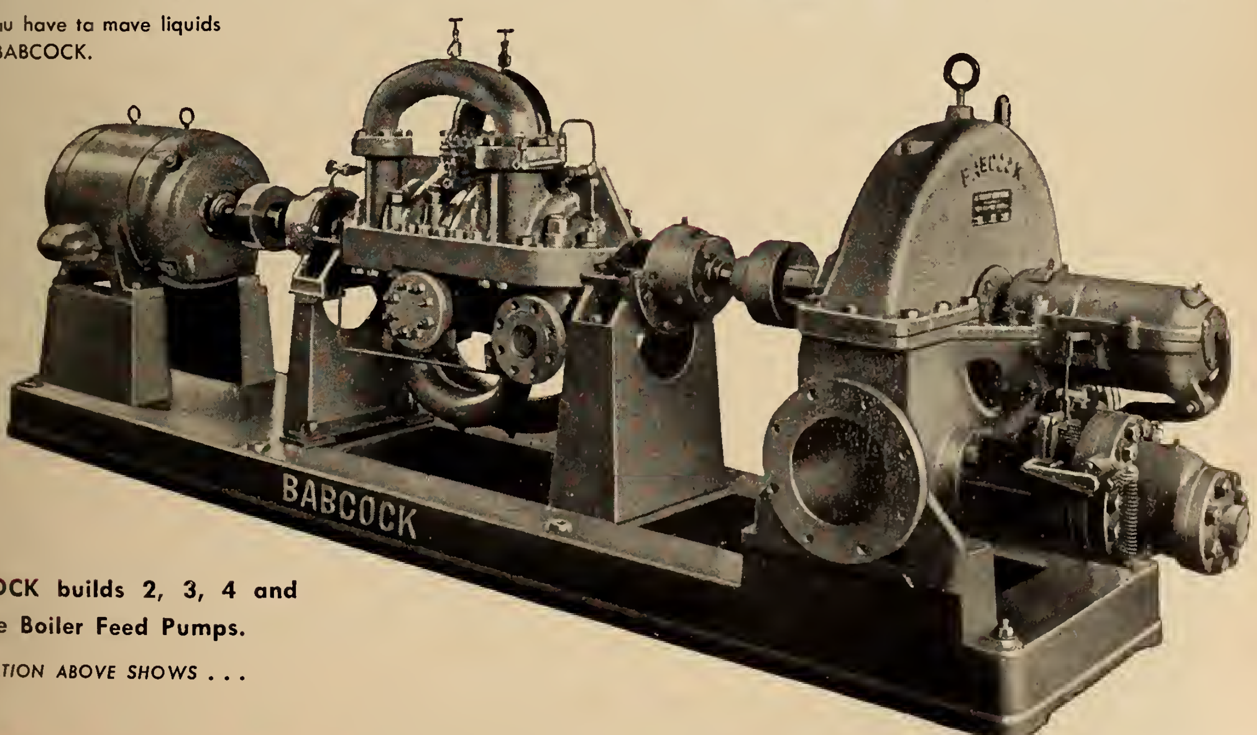

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• PERSONALS

J. C. Neufeld, M.E.I.C., city engineer at Lethbridge, Alta., since 1951, has resigned from that post. He will enter private practice as a consulting engineer in conjunction with an architect.

The firm, called Lurie and Neufeld, will specialize in design of buildings, sewerage, waterworks, and town planning.

In the years since his graduation from the university of Manitoba Mr. Neufeld's career has been largely devoted to work with the City of Winnipeg in structural design work and municipal engineering; with the Department of National Defence, Air Training Command, on the construction of sewer and water systems, during World War II; and with the Central Mortgage and Housing Corporation, Vancouver, in connection with veteran housing, as well as other National Defence projects in British Columbia.

R. T. Nolan, M.E.I.C., has relinquished his affiliations with the Nova Scotia Light and Power Company in order to devote himself to private practice.

Under the firm name, Nolan Bros. and Co., he is engaged in the work of consulting civil engineer and Provincial Land Surveyor.

Mr. Nolan is a 1947 graduate of the Nova Scotia Technical College.

J. J. Donahue, M.E.I.C., the 1957 choice of the St. John Branch of the Institute as chairman, is a native of St. John, a veteran of World War II and a graduate of the University of New Brunswick, class of 1944 with a B.Sc. in electrical engineering.

Mr. Donahue joined the New Brunswick Electric Power Commission following discharge from the R.C.N.V.R. and was employed as a line construction engineer. Later he accepted a position with the Power Commission of the City of St. John as a distribution engineer. In 1952 the Commission appointed him chief engineer.

J. J. Donahue, M.E.I.C.

Mr. Donahue has served as an Institute Branch officer, and in 1956 he was general chairman of the Atlantic Provinces Professional Meeting at St. Andrews, N.B.

D. B. Sutherland, M.E.I.C., formerly superintendent of new buildings with the Protestant School Board of Greater Montreal has been living in Vancouver for some time.

Mr. Sutherland is employed as the director of construction and maintenance with the Vancouver Board of School Trustees.

Geoffrey P. Webb, M.E.I.C., is once again resident in England after a period of employment in Caracas, Venezuela. Associated with Kennedy and Donkin, a London, Eng., firm of consulting engineers, he was transferred to the South American republic as their representative in the Caroni hydro-electric scheme.

Mr. Webb has also worked in Canada. In 1952, after his graduation from the University of London, he enrolled in the General Electric course at Peterborough, Ont., and then went on to spend a year with the company in the power transformer and switchgear sales division at Toronto. Later he was employed with the Aluminum Company of Canada as an electrical engineer on the Saguenay hydro-electric system at Shipshaw, Que.

W. Tannenzapf, M.E.I.C., has terminated his employment with the Brantford, Ont., firm of Crompton Parkinson Electric Limited.

He has accepted a position with Canadian Westinghouse Company Limited, at Hamilton, Ont. as a design engineer in the switchgear engineering-power product-division.

Mr. Tannenzapf, a graduate of the University of Prague, class of 1936, has had previous professional affiliations in this country, among them the post of switchgear contract engineer with Bepco Canada Limited at Montreal.

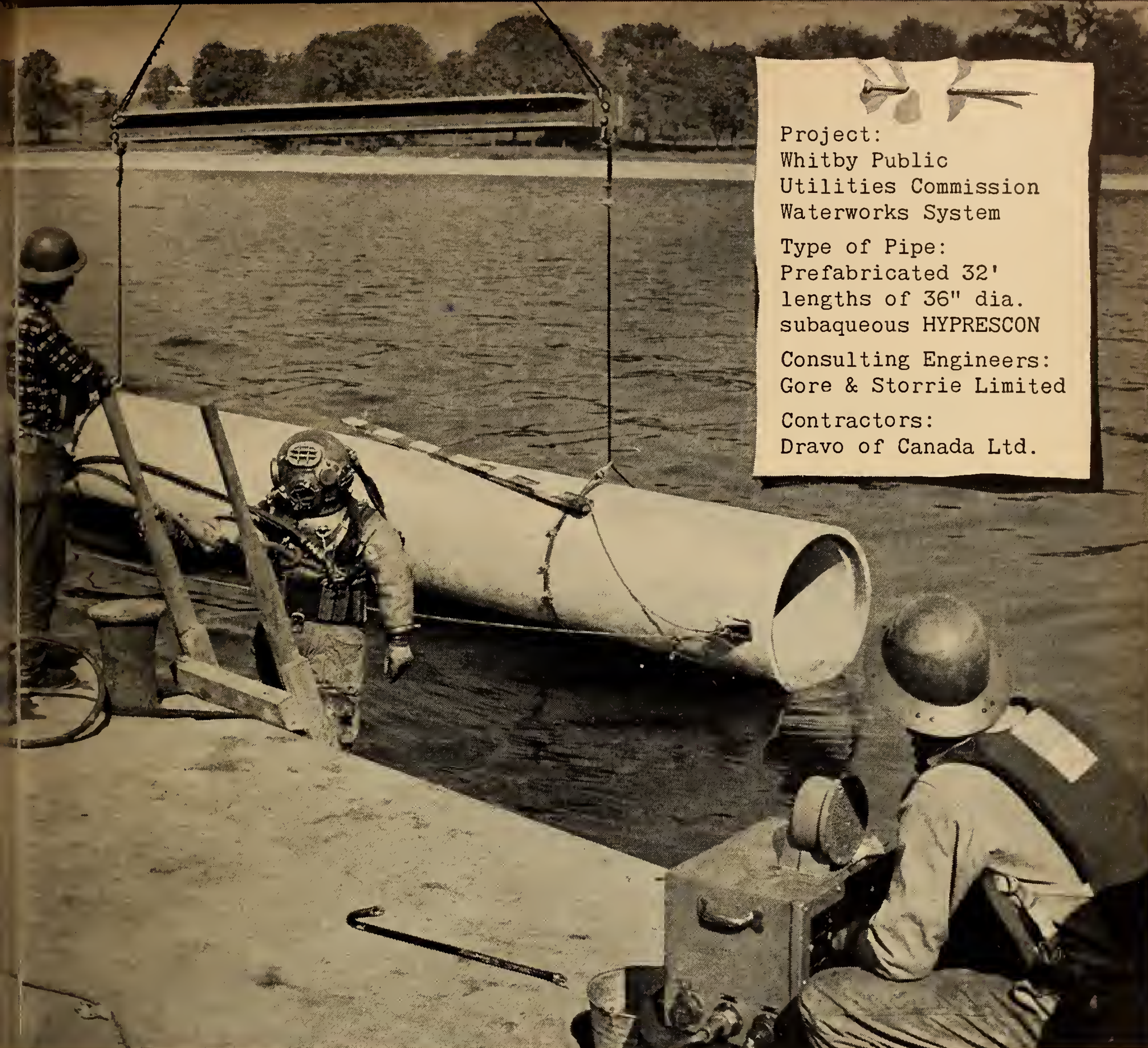
E. E. Robertson, M.E.I.C., has accepted an appointment as manager of planning and development with the Winnipeg Supply and Fuel Company Limited, Winnipeg, Man.

With the Foundation Company of Canada Limited, Montreal, for a number of years. His last position with the organization was as manager of bases.

Mr. Robertson is a University of Toronto graduate.

L. W. Swain, M.E.I.C., formerly with the firm of Babcock-Wilcox, and Goldie-McCulloch, at Galt, Ont., has accepted a position with Empire Brass, Limited at London, Ont.

Mr. Swain who came to this country from England has been engaged in design engineering at several Ontario centres, with W. C. Wood Company Limited,



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• PERSONALS

and the Cockshutt Plow Company since his arrival in 1948.

Before that time he had worked as a design engineer for a number of years and from 1946 to 1948 was a development engineer responsible for the design and development of all new products with a British firm.

R. J. Di Cicco, JR.E.I.C.

C. F. Buckingham, M.E.I.C., operating superintendent of the Maritime Electric Company Limited, Charlottetown, P.E.I., was recently appointed secretary-treasurer of the P.E.I. Branch of the Institute.

Mr. Buckingham also holds a similar office in the recently launched Association of Professional Engineers of Prince Edward Island.

A graduate of the University of New Brunswick, class of 1950 in electrical engineering, Mr. Buckingham joined his present employer at that time.

H. M. Anderson, M.E.I.C., who was previously employed with the Defence Construction (1951) Limited on the Gagetown Project has accepted a Toronto appointment with the firm of Perini Limited.

Mr. Anderson is a 1950 graduate in civil engineering from the Nova Scotia Technical College.

R. J. Di Cicco, JR.E.I.C., has been appointed chief mechanical engineer for the four mines and mills of the Asbestos Corporation Limited, at Thetford Mines, Que.

Mr. Di Cicco joined the Asbestos Corporation Limited early in 1956 as a maintenance superintendent of the King Mine and held that position until his recent appointment.

He was previously employed with Consolidated Paper Corporation Limited at Grand'Mere, Que., as Woodlands mechanical engineer. He joined the firm early in 1951 on graduation from McGill University in mechanical engineering.

George R. Durnin, JR.E.I.C., has moved from Winnipeg to Toronto in order to accept an appointment with the firm of Lescon Limited, Toronto.

With the firm of W. L. Wardrop and Associates in Winnipeg, since 1955 Mr. Durnin served as municipal engineer.

Prior to that appointment he was City engineer at Brandon, Man., for two and half years.

He is a 1948 graduate in civil engineering from the University of Manitoba.

B. C. Cameron, JR.E.I.C., of the firm of Babcock - Wilcox and Goldie-McCulloch Limited has flown to New Zealand to take up the position of assistant resident engineer for the company at the Mercer power station, near Auckland, N.Z.

He has recently been associated with the firm in England, at the Castle Donington, power station near Derby.

• PERSONALS

Mr. Cameron is a 1952 graduate of the University of Toronto in mechanical engineering.

Donald Shields, JR.E.I.C., a 1955 graduate of the University of British Columbia and winner of the Athlone Fellowship has completed his studies in Great Britain and has returned to Canada.

Mr. Shields studied at the Imperial College, London and received a post-graduate degree, (D.I.C.) in soil mechanics.

He has accepted employment with the Vancouver, B.C., firm of Ripley and Associates Limited consulting engineers in soil mechanics, foundations, asphalt mix design, wharf and harbour design.

J. Barriere, JR.E.I.C.

Gordon T. Marshall, JR.E.I.C., of the Railway and Power Engineering Corporation Limited has been named district manager of the corporation's operation in British Columbia with headquarters in Vancouver.

Mr. Marshall has served the Corporation for several years and was in 1955 employed as a sales engineer for Railway and Power Engineering Limited at Quebec city. Earlier he held an appointment at the Montreal office.

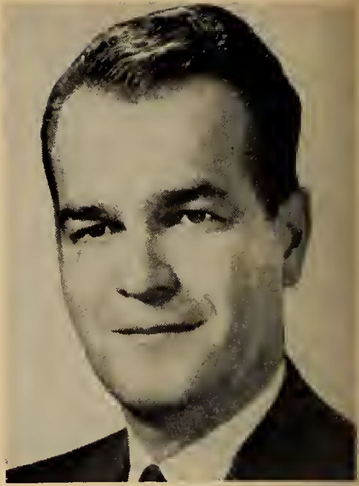
He is a 1950 graduate of McGill University, with a B.Eng. degree in mechanical engineering.

E. H. Birnie, JR.E.I.C., has accepted a position with Bristol Aircraft (Western) Limited, at Winnipeg.

He was formerly employed as a pilot with the Dorval Air Transport, Dorval, Que.

Mr. Birnie is a 1955 graduate of the University of Saskatchewan in mechanical engineering.

Jacques Barriere, JR.E.I.C, who has been appointed deputy director of the Traffic Department, City of Montreal, took post-graduate studies in traffic engineering at the Yale Bureau of Highway Traffic on an International Road Federation fellowship awarded in 1951 by the Canadian Good Roads Association.



G. T. Marshall, JR.E.I.C.

After completing a year's work at Yale University, Mr. Barriere, who is an Ecole Polytechnique graduate, class of 1950 in civil engineering, conducted a traffic study of 19 Canadian cities for the Canadian Good Roads Association.

Mr. Barriere is also secretary of C.G.R.A.'s Advisory Committee on Traffic, as well as being active in the joint project of the Canadian Good Roads As

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• PERSONALS

sociation and the Canadian Section of the Institute of Traffic Engineers, to produce a manual of uniform traffic control devices for Canada, being chairman of the French language committee and assistant editor of the executive committee.

John C. Vrana, JR.E.I.C., has accepted employment at Montreal with the Canadian Pratt and Whitney Aircraft Company, as an analytical engineer.

Mr. Vrana, whose previous professional association was with the National Research Council, division of mechanical engineering at Ottawa, is a 1953 graduate in engineering physics. He received his degree at the University of Toronto.

F. J. Cameron, JR.E.I.C., a territorial design engineer with the Harbour and Rivers Engineering Branch of the Public Works of Canada, London, Ont., has resigned from that position in order to accept a position in the consulting engineering field.

Mr. Cameron has joined the firm of Manley and Plant, consulting and contracting engineers, in Jamaica, B.W.I.

Mr. Cameron is a 1952 graduate in civil engineering from McGill University.

Gordon H. Good, JR.E.I.C., has moved from Kitchener to Hamilton, Ont., where he is engaged in mechanical engineering with the National Steel Car Corporation in that city.

Mr. Good has been recently employed with the B. F. Sturtevant Company of Canada Limited, as a sales engineer. He is a 1955 graduate of the Nova Scotia Technical College with a B.Eng. in mechanical engineering.

R. A. Gyles, JR.E.I.C., has transferred his services from the Renold Chains Canada Limited, Winnipeg, Man., to the Regina, Sask., firm of Bearing and Transmission Regina Limited.

A 1948 graduate of the University of Saskatchewan in mechanical engineering, Mr. Gyles has spent a number of years with the former company. In 1951 a sales engineer with Renold Coventry Limited at Toronto, he was later a branch manager of the firm in 1953.

Claude Marion, JR.E.I.C., formerly of the Shawinigan Water and Power Company, Montreal, has accepted employment with Canadian Stebbins Engineering.

Located for a few months at Watertown, N.Y., Mr. Marion expects to be transferred to Montreal later.

He is a B.Eng. graduate in electrical engineering from McGill, 1954.

J. D. Koppernoes, S.E.I.C., a 1955 graduate of the Nova Scotia Technical College, in mechanical engineering was awarded a master of science degree at the Massachusetts Institute of Technology in September, 1956.

Once again resident in Canada, he is employed with the Aluminum Company of Canada as maintenance engineer in the aluminum fluoride plant, at Arvida.

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NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

BELLEVILLE

E. T. HILBIG, JR.E.I.C.,
Secretary-Treasurer

Visit to Electric Plant

The January meeting of the Belleville Branch took the form of a visit to the Northern Electric Company in this city. The actual tour was preceded by talks given by two staff members.

Gordon Thompson delivered a talk on symbolic logic indicating how this form of algebra could be employed in studying switching arrangements and relaying in telephone or electronic circuits. His talk was well interspersed with humour.

The second speaker, W. J. Flynn gave a most interesting preview of a paper on modernization of a paint finishing area. As this paper has been or will be published in the Journal, no further comments are added herewith. However, this talk was unique in as much as an actual inspection of the paint finishing area could be and was made as part of the guided tour through the N.E.C. plant which followed.

Before proceeding with the tour, Mr. Punchard, plant manager, quoted some pertinent statistics and indicated how the local plant compared in size with others operated by the Northern Electric Company. Mr. Punchard and all those members on his staff who facilitated this visit are to be commended most highly for providing such an interesting and well organized tour. (Paper is on page 275.)

CALGARY

R. G. PRICE, M.E.I.C.,
Branch News Editor

Address on Refinery

On December 6, 1956, R. G. Walford, general superintendent of Sherritt Gordon Mines Limited, chemical plant, at Fort Saskatchewan, addressed an evening meeting of the Calgary Branch on the subject of the Sherritt Gordon nickel refinery.

The talk described in some detail the work of the refinery which is currently producing 20,000,000 pounds of nickel per year, small amounts of copper and cobalt and 85,000 tons per year of ammonium sulphate fertilizer. The refinery proper, as well as the research and development division, also situated at Fort Saskatchewan, gives employment to more than 600 people and has an annual payroll of approximately $2,500,-000.

Also briefly discussed was the history of Sherritt Gordon, the development of the unique pressure leaching-reduction process, and the economic and technical factors underlying the decision to locate its refinery at Fort Saskatchewan.

The main body of the address dealt with the refinery layout, a description of the various unit operations and major items of equipment, and an outline of the refinery organization.

Hear Highway Official

Wednesday, January 16, 1957, was the date of the combined meeting of the Calgary Branch and the Alberta Services Institute at the Garrison officers mess of the Calgary armories. The group were addressed by Brigadier Meuser, who spoke on "The Northwest Highway System." Brig. Meuser is in command of the System, maintained by the Canadian Army.

The Northwest Highway System is made up of the Alaska Highway plus certain adjacent and connecting roads. Brigadier Meuser flew down to Calgary from his headquarters at Camp Takhini in Whitehorse, Yukon Territory. Illustrating his talk with colored slides he outlined the problems envolved in maintaining the Alaska highway and keeping it open twelve months of the year.

Chalk River Problems Outlined

The second monthly meeting of the Calgary Branch, for 1957, was held on February 4, in the East Room of the Palliser Hotel. R. M. Smith of Atomic Energy of Canada Limited, addressed the meeting on engineering problems in the operation of the Chalk River reactors.

Introducing the subject, Mr. Smith outlined the nature of work being carried out at Chalk River as well as the reactor program. He discussed the principles of nuclear fission as to atomic structure, fission of uranium 235, and the uses of other reactor fuels. He described nuclear reactors from the point of view of purpose, types and components. In regard to the operation of reactors he deal with the subject of control of power operating procedures, instrumentation radioisotope production and experimental assemblies. Mr. Smith mentioned the difficulties in the operations of reactors and the distortion of fuel, contamination of heavy water and damage of experimental assemblies involved.

As to the future of nuclear reactor Mr. Smith was concerned as to the development and construction of reactor for the production of electrical powe and enumerated other uses to which reactors may be put.

In summarizing, Mr. Smith stated tha Canada is now embarked on a majo research and development program fo the construction of atomic reactors tha can be used for the production of elec tric power. Two research reactors ar now operating at Chalk River, two mor are nearing completion and a pilot powe plant is being constructed at the Ontari Hydro Electric site near Chalk Rive The operation of nuclear reactors pre sents many problems to the engineer such as distortion of fuel element, ver high operating temperatures and safe guarding of component parts.

Luncheon Club

The Noon Luncheon Club of th E.I.C. continues to hold regular meet ings every Monday at 12:15 p.m. in th Al San Club in Calgary. Out of tow members are especially welcome to a tend and already this year we have ha visitors from such distant points as Hal fax, Montreal, Toronto and Vancouve

EASTERN TOWNSHIPS

J. P. CHAMPAGNE, JR.E.I.C.,
Secretary

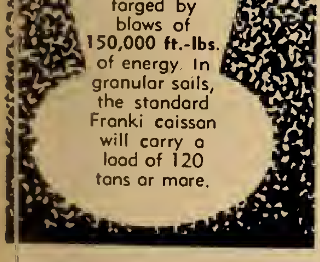
Highlights of European Trip

George M. Dick, Quebec, vice-presi dent of the E.I.C., was guest speak at the first monthly meeting of th Branch in 1957. The group met at th Club Social on Friday, January 18.

Taking the form of a "Ladies Night the meeting was under the chairmansh of Jacques Lemieux, Branch presider James C. Davidson, chairman of th program committee, introduced th speaker.

Sorel Arena, Sorel, P.Q. Consulting Engineers: Structural — Brouillet and Carmel, Montreal, P.Q.; Soil Mechanics — Foundation Engineering Co. of Canada, Montreal, P.Q. Contractor: Lucien Lachapelle, Sorel, P.Q.

Franki caissons permit erection of Sorel Arena



The Sorel arena was originally designed with foundations down to incompressible soils. However, the subsoil was found to consist of compact dark grey fine silty alluvial sand with clayey silt varves to depths greater than 80 feet. Consequently, the original foundation plans could not be considered because of cost.

The problem was solved by means of Franki pressure injected footings, concreted at a depth of 30 feet and the job was able to progress. 194 Franki caissons were used in all, 50% of them being inclined 15° with the vertical. The largest group of caissons used was 5 (4 inclined and 1 vertical).

Although a test of 90 tons produced a settlement of only 0.3", the piling was distributed to carry a working load of only 60 tons per pile. This permitted a maximum limitation of the horizontal movements of the arch abutments, since these movements were the determining factors for the whole structure.

LITERATURE on the various Franki methods of foundation and regular mailings of "Franki Facts" about job highlights, will be sent upon request. Write: Franki of Canada Ltd., 187 Graham Blvd., Montreal 16, P.Q.

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CAISSONS • UNDERPINNING • PILES

• BRANCH NEWS

Mr. Dick's address, on "Highlights of a Trip to Europe" was illustrated by a number of colored slides covering a wide range of European cities and landscapes. One of the interesting items in the address was a comparison of life and habits of the people of Paris and London and several other European cities such as Frankfurt, Copenhagen, Stockholm and Helsinki. The City of London, with its relatively quiet environment, contrasted sharply with the bustle, excitement and color of the Parisian scene. The beauty of the Swiss Alps and the little chalets in the foothills were well illustrated.

Journeys to Lapland, north of Sweden, and far beyond the Arctic Circle to visit the famous iron ore mines at Kiruna, were an interesting feature of the story, as were descriptions of life in the pulp and paper industry of Finland.

Accompanied by his wife, Mr. Dick also visited his native Scotland.

Summarizing the main aspects of the trip he commented on the opportunity which such a trip affords in noting other ways of life and in appreciating more than ever the benefits of life in Canada.

FREDERICTON

G. R. W. BLISS, JR.E.I.C.,
Chairman, Public Relations Committee

O. I. LOGUE, M.E.I.C.,
Secretary-Treasurer

Joint Meeting at Officers Mess

On Monday January 14, a joint meeting of the Fredericton Branch and the Military Engineers Association was held in the officers mess at Fredericton Area Headquarters. R. D. Field, chief engineer in charge of the Passamaquoddy survey, was guest speaker.

Brigadier J. R. B. Jones, brigadier in charge of Fredericton Area opened the meeting by welcoming the members of both branches to the officers mess. He then called on J. L. Feeney, chief engineer of the New Brunswick Electric Power Commission to introduce Mr. Field.

Mr. Feeney said that he had been associated with Mr. Field on various occasions in the past and that he always enjoyed working with him. He added that Mr. Field was a member of U.S. Army Corps of Engineers and that he has worked on some of the largest earth and rock fill dams in the U.S. He also stated that Mr. Field's many years of engineering experience made him an ideal man for his present job as chief engineer in charge of the survey for the International Passamaquoddy Tidal Power Project.

Outlines Production Schemes

Mr. Field began his talk by outlining the two schemes of producing tidal hydro electric power, explaining in detail the "one-pool" scheme and the "two-pool" scheme. In the "one-pool" scheme, while water is being stored during periods of high tide, the power plant must be shut down and no power can be generated. This would mean that the power plant would be idle about five hours each day. In the "two-pool" scheme, which is the scheme under investigation, one pool is kept at a relatively high level and the other at a lower level and power is developed by releasing water from the high level pool through turbines to the lower level pool. Thus continuous generation is possible.

Investigations Under I.J.C.

He then stated that the investigations are under the jurisdiction of the International Joint Commission and that the Commission has appointed an International Passamaquoddy Engineering Board comprised of two engineer members from Canada and two from the United States. This Engineering Board has been instructed to:

(a) Determine the most desirable general project design from the viewpoint of public interest;
(b) Develop plans for dependable costs and considerations of economic feasibility;
(c) make estimate of cost;
(d) determine if power production is economically feasible;
(e) determine effects, beneficial or otherwise, on local and national economics and national defence.

Mr. Field went on to explain his subject in more detail, referring to several slides of the area, and the different schemes that have been discussed. Following his talk he answered several questions. Ira Beattie offered the thanks of the members for the interesting and informative presentation.

Following a short break a business meeting was held with chairman, Ira Beattie in the chair. Plans for the remainder of the year were discussed. After the meeting members enjoyed a buffet luncheon.

HAMILTON

W. A. H. FILER, JR.E.I.C.,
Branch News Editor and Secretary-Treasurer

Annual Meeting Held

The annual meeting of the Hamilton Branch was held at the Hamilton Golf and Country Club in Ancaster on January 17, 1957. The evening began with refreshments, and dinner at 7:00 p.m. J. J. Kelly, Branch Chairman conducted the business meeting at which the slate of officers proposed by the nominating committee was adopted. They were: Chairman — D. B. Annan; vice-chairman, R. C. Mitchell; secretary-treasurer, W. A. H. Filer; executive committee; H. E. Archibald, E. R. Bushfield, H. E.

Seely, R. H. Stevenson; ex-officio, J. J. Kelly, A. F. Barnard; councillor, L. C. Sentence; and nominating committee member to E.I.C., N. A. Eager.

The Branch was privileged to have the President of the E.I.C. attend this meeting. Mr. V. A. McKillop who brought greetings from headquarters later presented certificates to the participants in the Students and Juniors Papers Competition of last March. They were J. H. Westaway, W. A. Piecsonka, and W. A. H. Filer.

G. L. Wilcox, president, Canadian Westinghouse Co. Ltd., Hamilton, Ontario, guest speaker of the evening was introduced by N. A. Eager, who outlined the varied career and achievements of Mr. Wilcox. He has received the Order of Merit from the Westinghouse Electric Corporation, the highest award given by this company for outstanding achievement in his service to the company.

The subject of Mr. Wilcox address was "Who Caused The Engineer Shortage, and What Can We Do About It". The address will appear in the April issue of the *Journal.*

LONDON

GEORGE HAYMAN, JR.E.I.C.,
Public Relations Chairman

GEORGE CHORLEY, JR.E.I.C.,
Secretary

Hears Quilliam

The London Branch held its first meeting in 1957 on January 15, 1957 in the Public Library Auditorium with more than fifty members and guests present, at what was generally regarded as a highly successful meeting.

The guest speaker, Brigadier C. D. Quilliam, O.B.E., of Kingston was introduced by Branch secretary George Chorley. In what Brig. Quilliam termed "a diagnosis of the Middle East problems" he traced the background which has influenced Arab thinking, and aims which have affected Israel's policies.

As the text of this address is fully expanded in the Toronto section of Branch News it will not be repeated at this time.

NIAGARA PENINSULA

P. A. SOLDAT, JR.E.I.C.,
Secretary-Treasurer

B. H. CHICK, JR.E.I.C.,
Branch News Editor

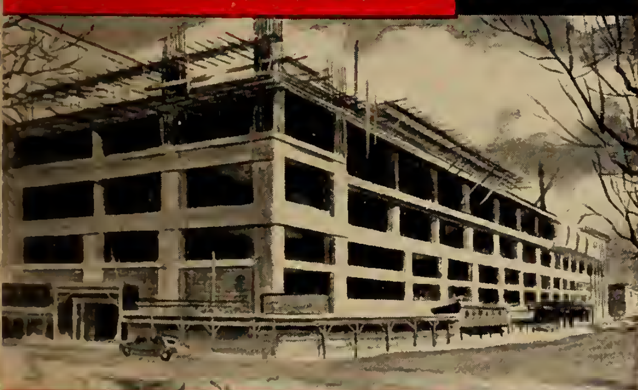
"Lap" LaPrairie Guest Speaker

A meeting of the Niagara Peninsula Branch was held in Port Colborne on November 29, 1956. Harold Treble in-what's your

PROBLEM?

Dusty Roads?

Ice Control?



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"Less Cost—Greater Safety"

• BRANCH NEWS

troduced the guest speaker of the evening, "Lap" Laprairie of the Explosives Department of Canadian Industries Limited.

Traced Development

Mr. Laprairie, with 39 years' experience with Canadian Industries Limited, traced the development of explosives and their applications. Of particular interest to the members were his illustrations of the uses of explosives in the construction of the Welland Canal and the Ontario Hydro Canal. A recent development, the blasting, was a feature of the construction of the Sir Adam Beck Generating Station No. 2. Mr. Laprairie also pointed out the advances his company had made in mine safety through research and tests.

SAULT STE. MARIE

L. F. MASON-TULBY, M.E.I.C.,
Secretary-Treasurer

E. A. Gilmore Guest Speaker

The Sault Ste. Marie Branch was pleased to welcome E. A. Gilmore, general superintendent of the Mannesmann Tube Company in this city, as guest speaker at the monthly meeting held January 30, 1957.

Mr. Gilmore was introduced by F. H. McKay, who explained that the speaker had spent his entire career in the highly specialized field of steel seamless tube making, including twenty years spent with the Pittsburgh Steel Corporation. This led to his later appointment as engineer in charge of hot mills at National Tube Company, and then to superintendent of the pipe and tube mills successively at Kirkland Steel Corporation and Colorado Fuel and Iron Company. Mr. McKay said that the speaker had been employed at Sault Ste. Marie for the past year, and added that the Engineering Institute was fortunate in having an address by one so well qualified in the tube making field.

Before proceeding with his talk on manufacturing techniques Mr. Gilmore explained some of the underlying reasons for the decision of the Mannesmann Company to establish a tube making operation in Sault Ste. Marie.

The meeting which concluded at about 10.30 p.m. was brought to an end by Gordon L. Brown who thanked the speaker and commented on the fine attendance and the interesting nature of the address.

Mr. Brown also accepted Mr. Gilmore's kind invitation extended to the Branch to enjoy a conducted tour of the plant at such time as it is in full operation.

NIPISSING AND UPPER OTTAWA

G. R. KARTZMARK, JR.E.I.C.,
Secretary-Treasurer

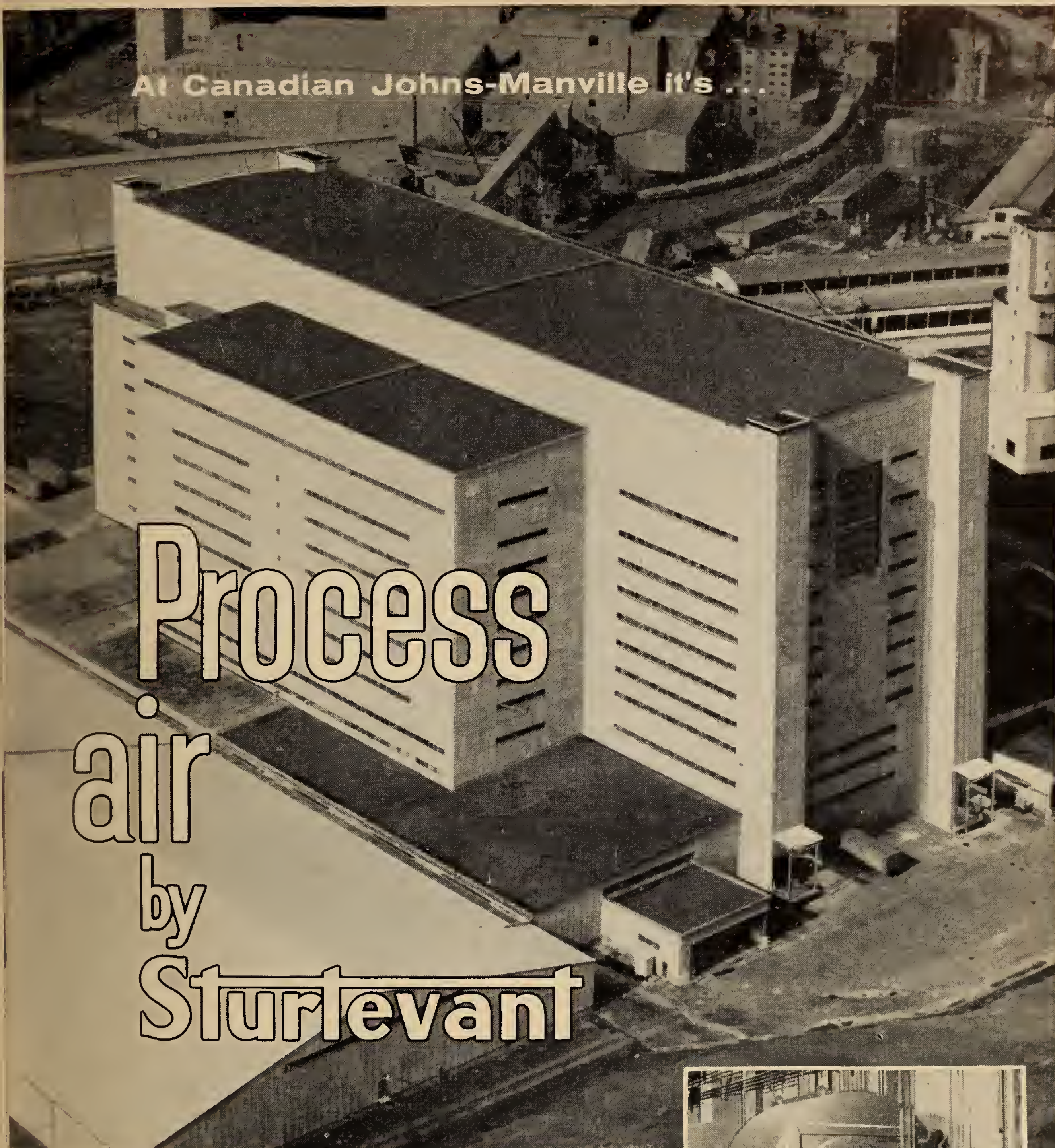
December Meeting

On December 12, 1957, the Branch played host to T. C. Macnabb, retired superintendent of the C.P.R. and father of Branch chairman, T. C. Macnabb. Mr. Macnabb Sr. spent his working years in helping build the C.P.R. in the great West. He described the many difficulties encountered in the progress of the railway and how they were overcome with available facilities.

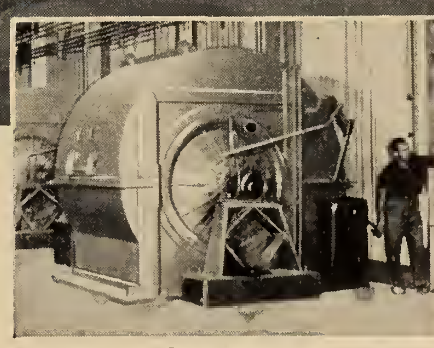
"Members Night"

The January meeting was held in North Bay, Ont., and constituted what is called "Members Night." One meeting a year is devoted to presentation of papers prepared by Branch members.

This year Mr. Snook of the Ontario



The new Jeffrey Mill of Canadian Johns-Manville Co. Ltd. is the largest producer of asbestos in the world! It processes 14,000 tons of ore daily. And for each ton of ore, 10 tons of air are needed to maintain production flow. To provide this tremendous volume of air, Johns-Manville relies on Sturtevant Airfoil Fans.



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AIRFOIL CENTRIFUGAL FANS

19 huge Sturtevant Airfoil Fans, each powered by a 350 HP Westinghouse Motor, supply air at the rate of 2,500,000 cfm for the Jeffrey Mill. These fans are capable of achieving a peak total efficiency of 92%. Making use of variable inlet vanes, considerable power savings are achieved over a wide range of performance requirements.

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• BRANCH NEWS

Hydro discussed the "Estimating of Peak Power Loads". Mr. Chantler of C.I.P. discussed the "Manufacture of Pulp". Both papers were well presented, and were followed by a very lively discussion period.

It is hoped that this will be a yearly event, enabling members to voice ideas.

ST. MAURICE VALLEY

J. H. A. LAVALLEE, JR.E.I.C., *Secretary*

W. A. PANGBORN, JR.E.I.C., *Publicity chairman*

Business Lectures Held

The St. Maurice Valley Branch has organized a series of five two-hour lectures for its members, on "Investment Finance and Stock Market," The lectures, held at Shawinigan Falls and Three Rivers, from February 4, to March 4, were similar to extension courses given in Canadian universities such as McGill, University of Montreal, Toronto and Laval Unversities.

At the universities these courses are given in co-operation with the Investment Dealers Association of Canada which has also agreed to undertake the project in the St. Maurice Valley, for the benefit of members of the E.I.C.

TORONTO

L. F. BRESOLIN, JR.E.I.C., *Secretary-Treasurer*

A. C. DAVIDSON, M.E.I.C., *Branch Editor*

Brigadier Quilliam, O.B.E.

At the Annual meeting, of the Toronto Branch on January 18, 1957, the regular business meeting was followed by an address delivered by Brigadier C. D. Quilliam, O.B.E. It was entitled "Events in the Middle East".

Brigadier Quilliam was introduced by D. Whitson, Toronto Branch councillor.

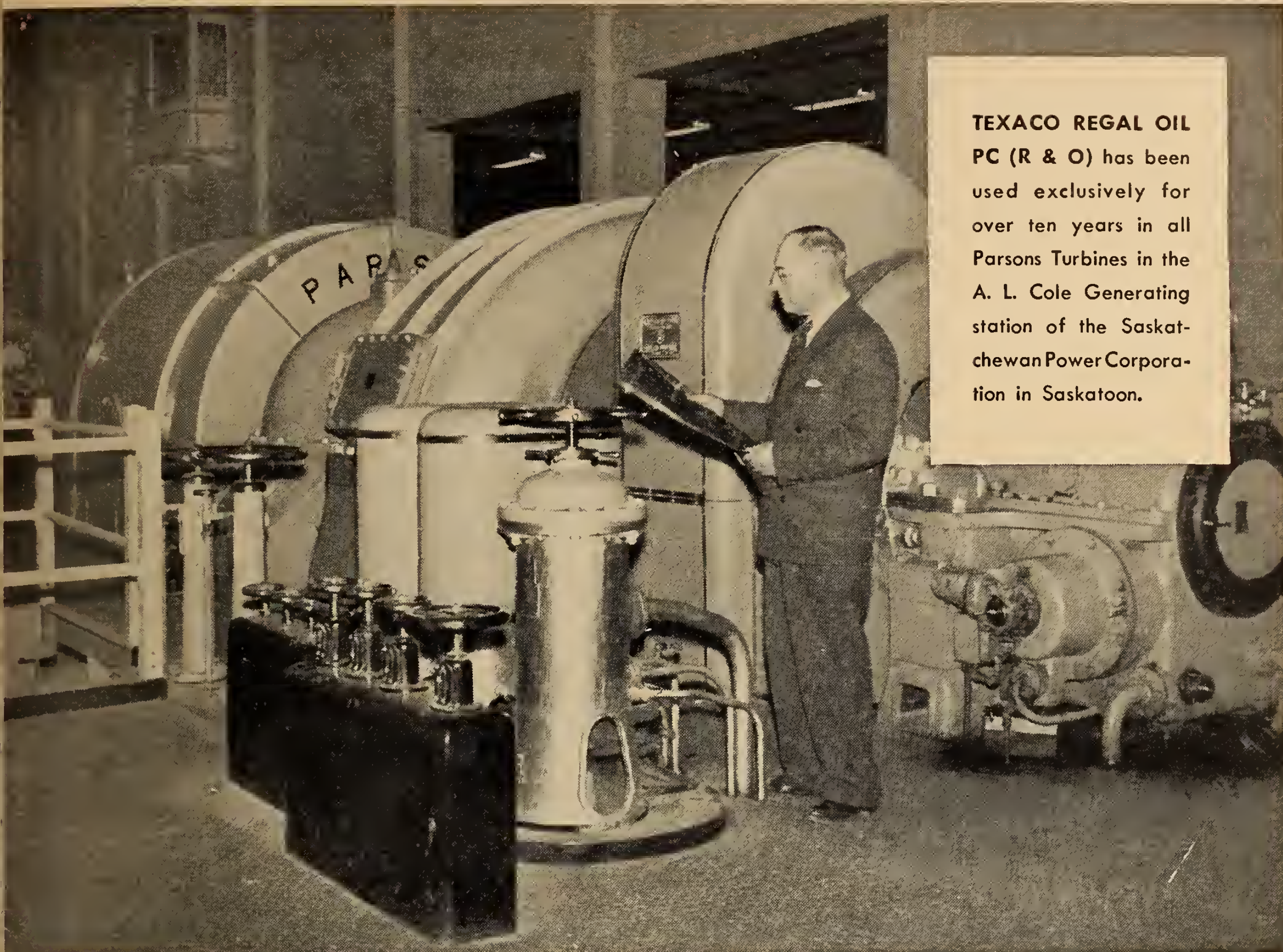
Background Situation. The speaker gave a very detailed background decription of the present situation in the Middle East making it clear at the beginning that next to Western Europe, the Middle East is the most important strategic area in the world and that it is necessary to maintain amicable relationships among the nations in the area or risk war with Russia.

The nations in the Middle East are comparatively new, coming into existence in the 1920's after the breakup of the Turkish Empire. These new countries took the British Empire as a mandatory guide, and developed under the expert supervision of the British Civil Service, whose selfless devotion to the development of the people with whom they worked is still a byward among the older generation.

Rift Created. The 1939-45 was created a rift in this harmonious relationship. The present representatives of the Western powers are not of the calibre of those who went before, and the younger generation do not remember or know what their fathers knew.

Nasser Represents Generation. Nasser is typical of this younger generation, which grew up in a frustration not of their own making, and who are endeavoring to make the Arab over into a fighting man which he is not and does not want to be. Nasser is a Moslem and believes in predestination, seeing himself as the man who will lead Islam into its rightful place in the world of politics.

Nasser's internal policy of installing reforms made the already poor people of Egypt worse off, and wrecked the economy. His external policy, the call to glory, is designed to direct attention away from this failure.



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"TURBINE SYSTEMS completely Free of deposits, oxidation and foam"

Mr. W. R. Riddell, Superintendent of this plant, states: "Texaco Regal Oil PC (R & O) has always given dependable performance as a turbine lubricant. All systems remained free of deposits, oxidation and foaming conditions. We are also very impressed by the length of service your oil continues to give."

Texaco Regal Oil R & O has been proved by test to have *ten times the oxidation resistance* of ordinary turbine-quality oils—far greater ability to keep systems free from sludge, rust and foam. And there is a complete line of *Texaco Regal Oil R & O* approved by all leading turbine builders for all types and sizes of turbines—as well as types and sizes of hydraulic equipment.

Let a McColl-Frontenac Lubrication Engineer help you select the proper one to keep *your* turbine and hydraulic equipment trouble-free. Just call the nearest of the many McColl-Frontenac Bulk Stations across Canada, or write: McColl-Frontenac Oil Co. Ltd., 1425 Mountain Street, Montreal 25, Quebec.

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• BRANCH NEWS

This external policy is threefold:

1) To prevent the development of Israel.
2) To see Egypt the leader in the Arab world.
3) To make Cairo the centre of Islam, and Egypt the leading country in Africa.

Policies Strange To Westerners. Although these policies may seem strange to a Westerner they are generated by the attitude of the West; and must firstly be countered by improving the quality of westerner going to the Middle East. The present type is not diplomatic. Secondly, Israel must be maintained as a small country. The Arab does not object to the Israeli, both are Semites, but he does feel that the West has treated the Jew veiy badly and the Western policy of creating Israel has worked hardship on fellow Arabs. Thirdly, the West must refrain from its practice of ramming its own materialism down the throat of Middle Eastern peoples. The Arab does not believe the Westerner's ideals are high; he is a mystic. The West worships success in business, sport and in pleasure. On the other hand, though the Arab might be backward in our eyes, he produced the prophets, Mohammed and Christ.

Lively Discussion The 140 members present entered into lively discussions over various aspects of the Middle East question, which proved as interesting as the talk itself.

The thanks of the meeting were tendered to Brigadier Quilliam by Don Beam, of the Canadian Institute of Steel Construction.

VANCOUVER

A. D. CRONK, JR.E.I.C.,
Secretary

T. F. HADWIN, M.E.I.C.
Branch News Editor

Inspection Trip

On January 12, the Vancouver Branch was treated to an inspection trip through the head office building of the B.C. Electric Company Limited, Vancouver, now nearing completion. About 100 members took advantage of the opportunity.

Three years were spent planning this building under the direction of Tom Ingledow, B.C. Electric vice-president and executive engineer. Many advanced features included in the design, the total cost will be about 6½ million dollars. Some of the interesting items of the project are listed below.

a) Temperature and humidity control: air conditioning and electric boilers using off-peak power to generate steam heat will maintain a constant climate, summer or winter.
b) Glareless, shadowless lighting: a new method using fluorescent lights behind a translucent plastic ceiling will bathe offices in light as the whole ceiling glows.
c) Moveable walls: partitions inside the building will be adjustable at 39-inch intervals to allow maximum flexibility and efficient use of the building's 360,000 square feet of floor space.
d) Automatic elevators: push-button operation will work with electronic control for service. Recorded voices will announce overloading or obstruction of the doors. Three of these elevators will travel to the twelfth floor, while the other three will provide service up to the twenty-first floor — the highest occupied building level in the city.
e) Automatic mail service: a conveyor system will carry mail to all floors from the mailing room.
f) A cafeteria on the main floor will serve employees with hot lunches. For summer use an open deck will be adjacent to the lunch room.
g) Two auditoriums will accommodate audiences of 200 and 100.

The inspecting group of engineers visited the below ground utility centres and were most impressed with the diagrammatic display of the heating and air conditioning system at the control centre which permits one man to control the conditions in all parts of the building while observing the exact readings telemetered to the centre. An elevator was then taken to the twenty-first floor and then a climb was made to the top of the 40 foot penthouse on the roof. This penthouse contains the water cooling towers and ventilating equipment.

Dropping down floor by floor the finishing was observed until at the third floor all was ready for the office partitions.

At the conclusion of the trip the chairman, S. S. Lefeaux, thanked Mr. R. M. Bibbs the B.C. Electric official in charge of arrangements and the engineers and contractors, John Laing and Son Limited, for a most interesting tour.

The new 6½ million dollar head office building of the B.C. Electric Company Limited at Vancouver, which Vancouver Branch members visited in January.

As the walls and interior were at that time in a state of progressive completion from the foundations up, it was possible for all stages of the construction to be observed.

News of Other Societies

C.C.A. Meets at Toronto

The annual meeting of the Canadian Construction Association was held in Toronto, January 20-23, 1957, with some 1200 delegates in attendance.

Committee Reports

The first general session on Monday morning was devoted to presentation of committee reports. Chairman R. H. Foss of the C.C.A. Apprenticeship Committee told delegates 7,400 registered apprentices for eight provinces was cause for something less than jubilation. The many new trades and skills coming into the industry should be worked into the training program. The number of journeymen being developed was quite inadequate to replace the skilled men who leave the industry, he pointed out. However, as various apprenticeship programs develop, more ex-apprentices are becoming superintendents, and are 'sold' on the benefits of training.

Chairman Bob Drummond of the Building Committee reported his committee's assignment had been completed, and "Construction House" was fulfilling its functions as Headquarters of the construction industry in the nation's capital.

H. R. Montgomery, chairman of the Construction Equipment Committee, reported the government had not yet closed the door on temporary importation of construction equipment into Canada without payment of full duties, but had referred all applications for import under special orders-in-council to the Association.

Following the major effort last year of preparing a brief concerning 'Capital Cost on Contractors' Movable Equipment,' referred to as the "Brief on depreciation rates", the Association felt the present rate of 30 per cent was unrealistic and a change to 40 per cent was appropriate. A new draft, if approved by Provincial Roadbuilders' Associations and other interested groups, would be seriously considered by the Minister, it was believed, and its recommendations would be acted upon.

R. F. Legget, chairman of the Contractor Relations Committee, referring to the question of 'bid-peddling' within the industry, stated the Committee had in September, 1956, been able to present a unanimous interim report, endorsing generally the idea of bid depositories, provided there was a local or regional demand for them. The Committee had recommended two resolutions to the Management Committee for the annual meeting in Toronto, generally endorsing the idea of bid-depositories.

Chairman J. Hastie Holden of the Legislation Committee reported that at the last annual meeting a resolution had advocated continued allowance of the option of using either the 'completion' or 'progress' method of reporting profits, if used consistently. National Revenue had ruled to this effect in 1953 with the qualification that projects lasting over two years should be subject to taxation returns based on the 'progress' method. This was allowed by the Department, which, however, ruled all unit-price contracts and all projects lasting two years would be reported on the 'progress' basis.

However, some members engaged in large-scale engineering projects were unhappy about the exceptions, and a brief was presented to the Minister in July, 1956. The association had been advised on January 3, 1957, by the deputy minister that a decision had been reached that "no change in departmental procedure should be made at the present time".

An amendment to the Export Credit Insurance Act had been promised by the Rt. Hon. C. D. Howe last year, to provide insurance coverage to contractors engaged on foreign projects. The legislation schedule had been delayed, however, and the amendment to the Act had not yet been made.

Speaking for the Sales Tax Committee, Chairman W. A. Marshall reported that practically all the Association's proposed additional exemptions to Schedule III had been included by the Department of Finance sales committee.

Chairman E. V. Gage of the Standard Practices Committee reported that the 'Suggested Guide to Bidding Procedure', advocated in 1952 at the C.C.A. convention, had been again taken up wit the R.A.I.C. during 1956 and the docu ment had been finally distributed wit the approval of both national bodies.

Following an interview last Februar with the federal cabinet, it was rule that tenders for all federal projects wit exception of Federal District Commissio jobs, 'secret' projects administered b D.C.L., and C.M.H.C., tenders at re gional offices were to be opened in pub lic. Representatives of the C.C.A. ar also permitted to be present fo C.M.H.C. tenders.

Chairman J. J. Pigott of the Labo Relations Committee announced that th association had prepared a brief to th Minister of Finance, asking for change in the treatment of board and travellin allowances paid to construction em ployees, which treated the workers ur fairly in its present form. The Depar ment of Labour had also been requeste to leave fair wage schedules include with tendering documents unchange for at least six months after these docu ments are issued, but so far the admini tration of the act remains unchanged.

Chairman V. L. Leigh of the C.C./ Housing Committee told delegates th in 1955 over half the loans under tl National Housing Act were issued those with annual incomes of $5,000 more. Only a small number obtainir loans had an income of less than $3,6(a year. Last year the number of loa

Officers of C.C.A., 1957

PRESIDENT, T. N. Carter, Toronto.

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PAST PRESIDENT: A. Turner Bone, Montreal.

HONORARY SECRETARY: R. A. Seasons, Ottawa.

HONORARY TREASURER, D. L. Donaldson, Ottawa.

had dropped, and those going to people earning more than $5,000 had increased. Provisions of the N.H.A. should be broadened, he said, otherwise the proportion of loans issued to those deserving of assistance when the act was passed would be even smaller in 1957.

President's Address

Association President Alan Turner Bone, told the meeting that in spite of a steel strike and a tight credit situation, the industry had a volume of over $6 billion for 1956. This represented some 20 per cent of Canada's gross national product, and gave direct employment to over half a million Canadians.

Barring major upsets to the economy, predicted the speaker, it appeared likely there would be a further increase of 5 per cent to 10 per cent in the volume of construction this year. This would, of course, be dependent on further increases in the supply of materials and machinery.

The leading Canadian banks were fairly unanimous in agreeing something must be done to prevent inflation, but frankly disturbed that the burden from higher interest rates and restriction in funds available for business loans was borne unevenly by different parts of the economy. "Since the federal government is concerned about the demand for credit, would it not be desirable for it to reduce the amount of credit tied up on public works contracts" asked the speaker, "such steps might include smaller security deposits, substitution of bonds, progressive release of holdbacks and faster payments." A government job took four times as much working capital as was required by a contractor for a private job of similar value, he observed.

The housing section of the industry had been the one most seriously affected by the present situation.

What concerned the average general or trade contractor most was that he must pay more now for his credit facilities than formerly, and that he could no longer count on getting credit facilities in line with his requirements.

What disturbed him most, continued the speaker, was that the credit curbs seemed to be directed principally against construction, the very industry so vital to the growth of our country and the one that should be the last to be subjected to them.

Efficiency and profits were both needed for business success, said Mr. Turner Bone. The problem was psychological, and called for leadership on the part of the big operators who had the most influence on the trend of prices.

Prime Minister the Guest Speaker

The guest speaker at the annual banquet was the Rt. Hon. Louis St. Laurent, Prime Minister, who predicted current shortages of money and materials would be greatly intensified in the coming year, with planned capital investment expected to climb to a new high of $8.7 billion. The money intended to be invested in expanding the economy by building new plants, shops, offices, houses, schools and other facilities and equipping them, he said, would rise by some 12½ per cent this year, roughly $1 billion higher than in 1955. Of the total increase, some 7 per cent would represent greater volume. The other 5 per cent would represent higher prices. The 7 per cent greater volume would greatly intensify the present shortages and something would have to yield, either the competition for funds or the competition for labour and materials.

The demand for many products was so strong that producers might be willing to pay more for loans than those borrowing to build houses. On the other hand, said the Prime Minister, he expected that over the longer term there would be a good supply of funds available for housing. He expected the present shortage of funds to relax somewhat, back towards what had been experienced during the past five years.

These difficulties, said Mr. St. Laurent, were symptoms of health and economic strength, not of weakness; evidence that competition was at work, not that it was being interfered with. The Government and the Bank of Canada took the view that the quantity of money should not be increased in a manner and to a degree that would strengthen significantly the inflationary tendencies.

Sectional Meetings

At the second sectional meeting on Tuesday, R. G. Johnson, president, Defence Construction (1951) Limited, addressed the General Contractors Section on federal construction projects, while Major General H. A. Young, C.B., C.B.E., deputy minister, Department of Public Works, discussed the activities of his Department. C. E. Hipp, vice president, Canadian General Electric Co., Ltd., addressed the Trade Contractors Section on business management and profits.

On Wednesday, the Manufacturers and Suppliers Section attended a panel discussion on "Where Research is Heading in the Construction Industry". The speakers were C. O. P. Klotz, Aluminum Company of Canada, on aluminum and related metals; J. B. Armstrong of the Plywood Manufacturers Association of B.C., on plywood; and L. H. Corning, Portland Cement Association, on prestressed concrete. C. C. Pettit, Canadian Paint and Varnish Association and P. V. Johnson of Structural Clay Products Research Foundation, addressed the meeting on paint and structural clay products respectively. R. F. Legget, director, Building Research, NRC, acted as moderator.

Calendar

Welding

The annual spring meeting of the American Welding Society (12 E. 41 Street, New York 17, N.Y.) is planned for April 8-12, in Philadelphia. At the same time the annual welding show will take place.

Electrical Engineering

The Canadian Electrical Association plans the annual meeting, 1957, for June 19-21, at Murray Bay, Que.

Headquarters of CEA is at Room 714, Tramways Building, Montreal 1, Que.

Colloquium on Radiation Effects

It is announced that on March 27-29, 1957 the Office of Naval Research and the Martin Company will co-sponsor a colloquium on Radiation Effects on Materials to be held on the campus of Johns Hopkins University, Baltimore.

Information is available from Dr. J. G. Morse, Supervisor, Radiation Effects Unit, Nuclear Division, Mail No. 711, Martin Company, Baltimore 3, Maryland, U.S.A.

Chemical Engineering

The American Institute of Chemical Engineers (25 West 45th St. New York 36, N.Y.) announces 1957 meetings as follows: White Sulphur Springs, Virginia, March 3-6; Seattle, Washington, June 9-12; Baltimore, Maryland, September 15-18; Chicago, Ill.; the annual meeting, December 8-11.

Irrigation and Drainage

The third congress of the International Commission on Irrigation and Drainage will be held in San Francisco, Calif. April 29 to May 4, 1957. This is the first such congress in the United States

Information may be obtained from the United States National Committee of the Commission, P.O. Box 7826, Denver 15 Colorado.

Radio and Electronics

The fourteenth annual exhibition organized by the Radio and Electronic Component Manufacturer's Federation is to be held at Grosvenor House and Park Lane House, London, W.1, from April 8 to April 11, 1957.

Heating and Ventilation

There will be International Session on Heating, Ventilation and Air Conditioning, May 27, 28, 29, 1956, in Paris

L'Institut Technique du Batiment et des Travaux Publics (6, rue Paul-Valery Paris XVI) is arranging the meetings.

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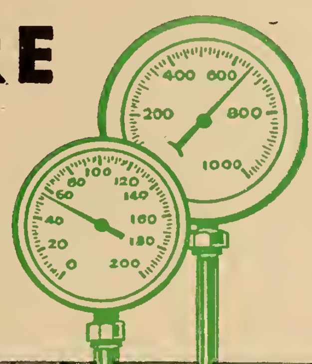

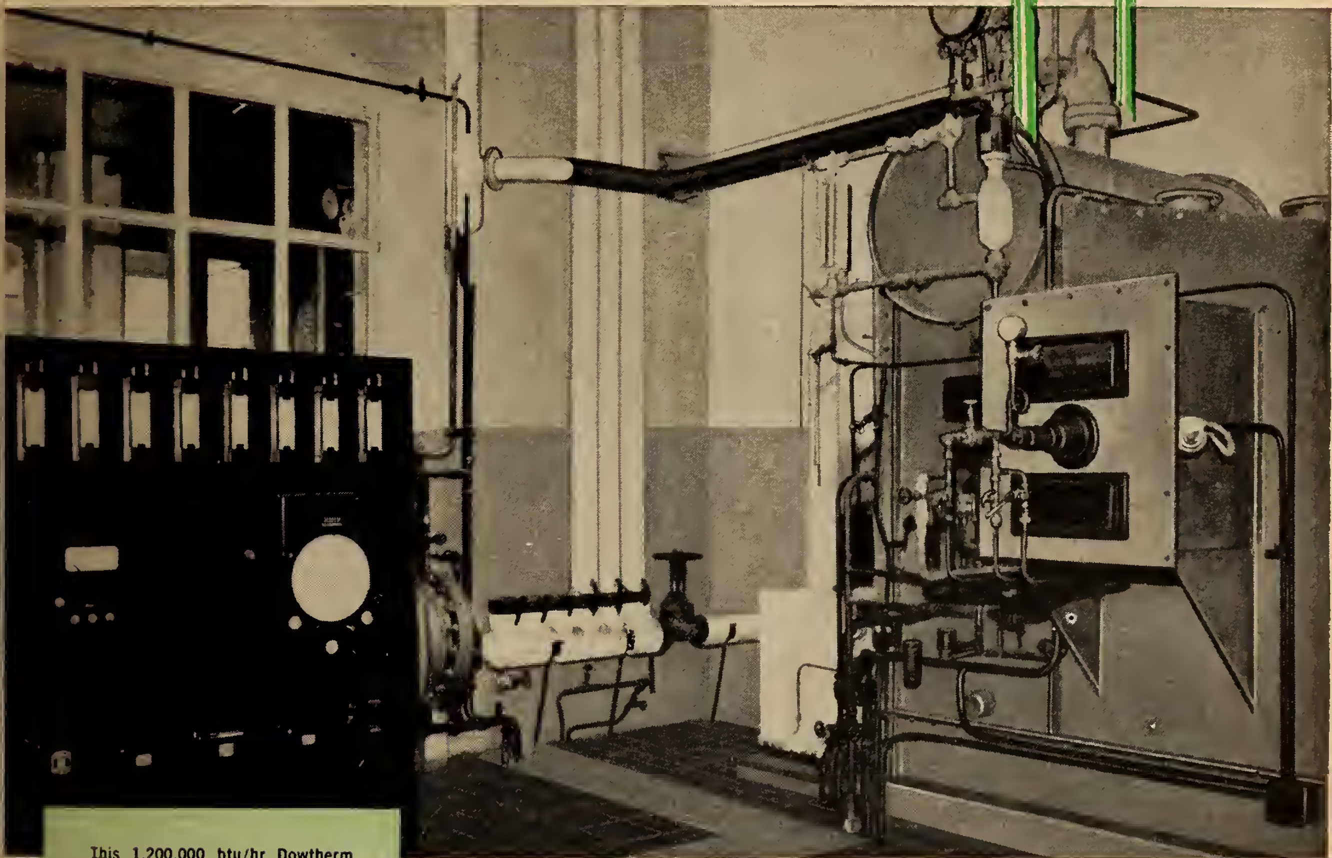

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BOOK NOTES

Prepared by The Engineering Institute of Canada

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

Bridging the Years

C. M. Norrie. London, Arnold, Toronto, Macmillan, 1956. 212p., illus., $4.00.

A short history of British civil engineering written primarily for the young civil engineer, this book should prove of interest to a much wider audience.

The author begins his history with brief biographies of the early engineers, Brindley, Smeaton, Rennie and Telford. He surveys the effects of the industrial revolution on the civil engineer, and recounts the engineer's contributions to the great railway building era of the nineteenth century. There are two chapters describing notable British civil engineering works of the period, and the final chapter surveys the years following 1914.

As the author points out in his introduction, today's engineers are at the beginning of a new era, as were those at the end of the eighteen century. At that time the potentialities of coal and iron were just being realized, whilst today it is nuclear energy which is occupying such a prominent position.

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS

Monday to Friday

9 a.m. — 5 p.m.

Saturday 9 a.m. - 12 noon.

Calculus Refresher for Technical Men

A. A. Klaf. New York, Dover, 1944. 431p., $1,95 (U.S.)

Presented in easy-to-understand question and answer form, this 'refresher' is divided into three sections. The first covers simple differential calculus; constants, variables, functions, increments, derivatives, differentiation, logarithms etc. The second covers fundamental ideas of integration; inspection, substitution, areas and volumes, mean value, etc., while section three gives illustrations of the applications of calculus to various problems encountered in the different fields of engineering and technology.

The Climate of British Columbia and the Yukon Territory

W. G. Kendrew and D. Kerr. Ottawa, Dept. of Transport, 1955. 222p., maps, tables. $1.00.

This is the second in a series of climatological reports on Canada. Part 1 covers southern British Columbia, part 2 northern British Columbia and the Yukon territory. Topics covered in each section are: regional divisions; pressure systems; air masses and frontal zones; surface winds; temperature and humidity; cloud sunshine; preciptation; visibility. Climatological tables are given throughout the book for various regions, as well as tabulated data on the subjects covered by the text, including means of temperature, pressure, etc.

The Elements of Mechanics and Mechanisms

F. J. Camm. Toronto, British Book Service, 1956. 431p., illus., $5.10.

Revised and expanded from a series of articles appearing in the periodical *Practical Mechanics*, this text provides an elementary guide to mechanics and mechanisms. The topics covered include: the laws of motion, friction, mass and momentum; force, energy and power; conduction, convection, radiation and heat; the lever; the wheel and axle; the gear; the inclined plane; hydraulics; intermittent mechanisms; and power transmission.

*Engineering Inspection, Measurement and Testing

H. C. Town and R. Colebourne. New York, Philosophical Library, 1956. 191 p., illus., $7.50 (U.S.).

The greater part of this book is devoted to descriptions of various devices and to brief indications of their applications. The devices covered include comparators, linear measuring machines, multi-dimension inspection machines, auto-collimators, etc. Also dealt with are the functions of the inspection department, principles of precision measurement, measurement during machining, inspection methods and calculations, screw-thread measurement, and the measurement of surface finish.

*The Fatigue of Metals

London, Institute of Metallurgists, 1956. 148p., illus., 17/6.

This book contains a general discussion of fundamentals and four lectures devoted to the effect on fatigue of notches, surface finishes, etc.; structural aspects of aircraft fatigue; corrosion fatigue; and the effect of temperature on fatigue properties. At the end of the book is a tabulation of fatigue data on a number of alloys.

F.B.I. Register of British Manufacturers. 29th ed.

Federation of British Industries. London, Iliffe, 1956. 1129p., 42/-.

This directory of British firms lists 7500 companies in two ways: alphabetically by name, and classified by products and services. Various means to aid in consulting the directory are given, such as French, German and Spanish glossaries, a list of brand and trade names trade marks, and trade associations.

The Grenville Problem

G. E. Thompson. Toronto University Press, 1956 119p., tables, maps. $3.95. (Royal Society of Canada special publications no. 1)

The Grenville subprovince, as part of the Precambrian shield of eastern Canada, and yet of different structure presents something of a puzzle to geologists. There has been some investigation of its rock types and mineral content, and some

industrial minerals have been developed recently. This has led to further interest in exploring the region. The contributors to this symposium represent mining companies, government surveys and universities. It is not a comprehensive survey of all that is known regarding the Grenville subprovince, but rather a number of papers on particular aspects of the problem.

Hi-Fi: from Microphone to Ear

G. Slot. Eindhoven, Philips, 1956. 169p., illus., $2.75 (U.S.)

This book explains and discusses the technique and technical problems of the recording and reproduction of sound. The apparatus and factors affecting these processes are given in order, beginning with the pressing of records. Following this the subjects covered are: the operating principles and characteristics of pickups, the needle and record, amplifiers, loudspeakers, acoustic problems, high fidelity, and magnetic tape.

The High Girders

John Prebble. Toronto, British Book Service, 1956. 219p., illus., $4.25.

There were many who believed that the North British Railway Company was attempting the impossible in erecting a bridge across the estuary of the River Tay. The bridge would be over two miles long, the longest span erected over open water up to that time. However, the bridge was completed in 1878, and Queen Victoria herself crossed some months later.

The sceptics' fears were realized in December 1879 when, during a gale, the centre span, "the high girders" collapsed while a train was crossing, drowning seventy-five people.

The High Girders is an account of the erection and collapse of the bridge, and the enquiry which followed its destruction. It makes fascinating reading, and shows how important a part the human element can play in an undertaking of this type, although it seems certain that with the technological advances of the last seventy years, a similar tragedy could not now occur for the same reasons.

*Information Theory and its Engineering Applications, 2nd ed.

D. A. Bell. Toronto, Pitman, 1956. 174p., $5.00.

This is a concise summary of the substance of recent developments, using only the mathematics ordinarily familiar to the electrical engineering or physics graduate. Chapters deal with the binary digit measure, entropy and information, signalling speed, signal-to-noise ratio, and coding. Applications such as pulse-modulated telephony, radar storage-systems, and colour television are also discussed. A new chapter on decoding has been added to this edition.

International Dictionary of Physics and Electronics

W. C. Michels, ed. Toronto, Van Nostrand, 1956. 1004p., $22.00.

Compiled by a group of distinguished scientists and educators, this dictionary has taken over five years to prepare. It includes the principle terms used in classical and modern physics, and pure and applied science.

The dictionary is intended not only for physicists, but also for those in other fields such as chemistry, biology, and engineering who frequently need information about terms used in physics. For this reason in many cases two definitions have been given for a term — a "simple" explanation, and a more detailed one.

The definitions in the volume are, wherever possible, those recommended or established by recognized groups.

For the sake of those without an extensive mathematical background, definitions of many of the mathematical terms used in physics are included.

The twelve thousand definitions cover the fields of mechanics, heat and thermodynamics; low temperature physics; the properties of gases, liquids and solids; acoustics; optics; electricity; electronics; nuclear physics; mathematical physics; and representative topics in relativity. The terms defined include laws, relationships, equations, and basic principles and concepts.

Jay-Bird feather lacing ...and the 105-ton boring machine

THE FEARSOME GENTLEMAN depicted on this page is *not* a Roman centurian from Cecil B. DeMille's "The Ten Commandments." He is a Japanese general, circa 1400 A.D., fashionably accoutred for a good hard equestrian bout of swordsmanship. His handsome suit was manufactured by Japanese craftsmen from the finest materials, including iron scales, black-lacquered leather, and textile braids cunningly woven to duplicate the feathers of the jay-bird.

Cuirasses with jay-bird feather lacing have been out of date in Japan—as proper dress or as a heavy production item—for several hundred years. These days, Japan's metal-working craftsmen are busy turning out 80,000-ton ships, railway rolling stock, oil casings, drilling rigs, hydraulic and thermal power generators, flour mills, earth-moving equipment, cold strip and electric plating mills, rotary kilns, pneumatic tools, and assorted machines that produce such commodities as cans, matches, textiles, pills, buttons and toothbrushes. Two years ago a Tokyo works built a gear-hobbing machine that allows only six seconds maximum pitch error, compared with the world's previous best of 12 seconds pitch error. Another Japanese firm has completed a boring machine of 105 tons net weight with a main spindle 250 mm. in diameter.

These and similar engineering achievements indicate the range of productive capacity in the New Japan, where just about anything an engineer is likely to ask for can be obtained from inventory or constructed to specification.

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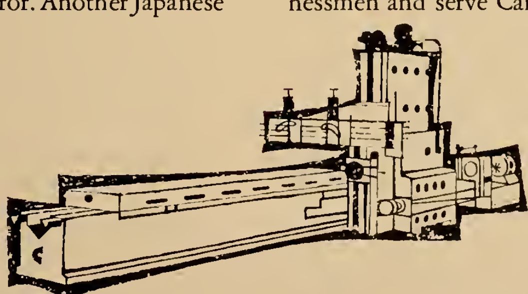

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● LIBRARY NOTES

The dictionary is carefully cross-indexed, and the units used in physics are included in the definitions and discussed in the introduction.

The dictionary is almost a library in itself, and, an important consideration, the type is particularly easy to read.

Introductory Electrical Engineering

G. F. Corcoran and H. R. Reed. New York, Wiley, 1957. 527p., diagrs., $7.95.

Intended as an introductory text in electrical engineering, the book is based on Corcoran's *Basic Electrical Engineering* published in 1949. If it is desired, the first five chapters may be used by themselves for a short course.

Revised and re-written, it covers the electric charge and current, d-c circuit analysis, magnetic field concepts, magnetic effects, ferromagnetic circuits, inductance, the electric field, capacitance and boundary-layer voltages.

Kempe's Engineers Year Book, 62nd ed.

London, Morgan, 1957. 2v. 82/6.

This standard reference work, now in its 62nd edition, needs no introduction. Each section has been brought up to date, and the two volumes cover all aspects of engineering.

Major changes in this edition include new chapters on gearing and diesel locomotives. Additional material is given on of shot and grit blasting and machinery railway brakes; electric traction; methods employed; hydraulic copying lathes; demagnetizers; new types of tipped tools, and transfer machining processes; high temperature alloys and nickel alloys; shell moulding and the carbon dioxide process; revised tables on non-ferrous metals and alloys, magnesium alloys and titanium alloys; atomic power; liquid pumps, and hydraulic transmission of power; bearing materials, slotted metal sections; the gyroscope; pump turbines and the feathering Francis turbine.

As usual, each section contains a selected bibliography.

Laboratory Administration

E. S. Hiscocks. Toronto, Macmillan, 1956. 392p., illus., $7.00.

In this book, the Secretary of the National Physical Laboratory in Great Britain examines the requirements in the organization and management of research laboratories which will provide the conditions in which scientifc work can be most productive. Concerned with both governmental and industrial laboratories employing more than 200 people, the book deals with the functions of the director and the staff, recruitment, salaries, finance, technical services, buildings, training for management, and other matters, related to the day-to-day running of a research establishment. Some data on costs are given.

Manual of Reclaimed Rubber

J. M. Ball, ed. New York, Rubber Reclaimers Association, Inc., 1956. 94p., $3.00 (U.S.).

The processing and manufacture of reclaimed rubber is an integral part of the rubber industry, since knowledge of effective methods of reclamation has kept pace with the need for more and better synthetic and natural rubber products. This manual contains data on types of reclaimed rubber; compounding of reclaimed rubber; and commercial uses of reclaimed rubber. Appendices cover laboratory test methods, chemical analysis, and a bibliography is included.

National Directory of the Canadian Pulp and Paper Industries

Gardenvale, Que., National Business Publications, 1956. 514p., $5.00.

In this edition, listings of pulp and paper mills, paper converters, distributors, and merchants have all been brought up to date. A classified directory is included at the end. In the geographical section listings include company ad-

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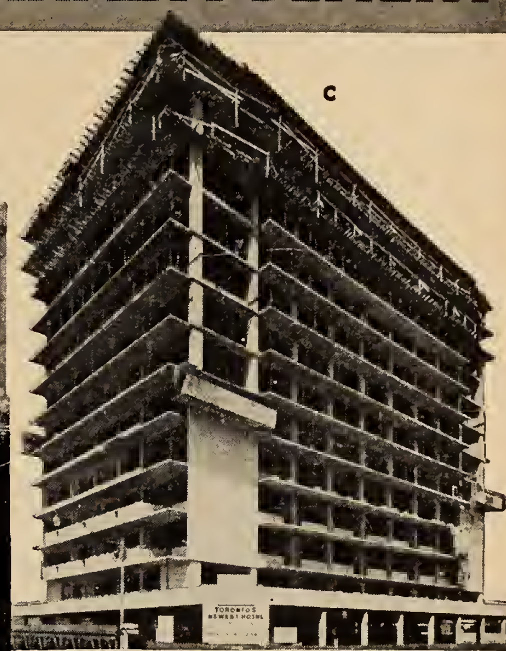

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Architects:
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Smith Brothers & Wilson Ltd., Regina.

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Architects: Page & Steele, Toronto.
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Apartment Building, Toronto.
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General Contractors:
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dresses, freight connections, officers, directors, personnel, capitalization, agents, number of employees, equipment, production, etc. Paper products manufacturers and trade associations are also listed.

The National Reference Book, 11th ed.

L. M. Durant. Montreal, Canadian newspaper service, 1956. 1499p., illus.

This reference work contains bibliographical sketches and photographs of prominent Canadian businessmen. The last section contains miscellaneous information entitled Facts and Figures on Canada. An extremely useful Business Directory is included, listing Canadian firms and giving a list of officers for each together with other pertinent information.

Pictorial Microwave Dictionary

V. J. Young and M. W. Jones. New York, Rider, 1956. 110p., diagrs. $2.95 (U.S.)

This dictionary lists the more important terms in the comparatively new field of microwave technology giving derivation, explanation, definition and illustration. It does not attempt to be comprehensive since the explanations given are encyclopaedic, as this type of definition is thought to be of greater value than a more concise entry. The dictionary is written for persons with basic technical knowledge.

The Plastic Methods of Structural Analysis

B. G. Neal. Toronto, British Book Service, 1956. 353p., $7.75

The plastic methods of structural analysis have been developed for calculating the plastic collapse loads for frames, with the idea of establishing a rational and economical design procedure. The calculations involved are simpler than those which must be made for an elastic analysis of the same structure.

The author, now chairman of the Department of Engineering at the University College of Swansea worked at Cambridge under Professor J. F. Baker who is a British authority on the subject, and at Brown University under Professor W. Prager who holds a similar position in the United States.

The plastic methods of analysis are presented in the first four chapters of the book, while the other four chapters deal with associated topics; estimates of deflections, factors affecting the fully plastic moment, minimum weight design and variable repeated loading. Included in the appendices are proofs of plastic collapse and shake-down theorems, tables showing the plastic moduli of British Standard beams and notes on plastic theory and trusses. There are useful bibliographies at the end of each chapter.

Practical Mechanics Handbook, 8th ed.

F. J. Camm. Toronto, British Book Service, 1956. 400p., illus., $2.75.

A mine of information for the Do-it-yourself enthusiast, this handbook includes information on lathe work, small tools, filing, fitting and marking out, the dividing head, hardening and tempering, electro-plating, brazing and soldering, etc.

Frequently used information is presented in tabular form, and there is a useful index. This is a valuable guide for those interested in metalworking.

Prospecting in Canada, 3d ed.

A. H. Lang. Ottawa, Dept. of Mines and Technical Surveys, 1956. 401p. illus. $2.00. (Geological survey of Canada. Economic geology series no. 7.)

Because of the importance of the discovery of new mineral deposits to Canada's mining industry, this third edition has been published to give prospectors the scientific information and modern technological knowledge necessary for successful prospecting. Subjects covered include: the geology of Canada; equipment and travel; conventional and spe-

cial methods of prospecting, geophysical, geochemical etc; exploring and appraising mineral deposits; notes on metals and minerals; placer and small-scale lode mining, and mining laws. Suggestions for additional reading are given in each section.

Radio Telemetry, 2nd ed.

M. H. Nichols and L. L. Rauch. New York, Wiley, 1956. 461p., illus., $12.00.

This is essentially the first work to gather together the basic information on radio telemetry, as the earlier edition, published in 1954, was for use by the U.S. Air Force.

The background covered includes environmental and inherent errors, frequency and time domain analysis, modulation and multiplexing, minimum signal strengths and thresholds, sampled data smoothing, and interpolation. The authors analyze current telemetry practices and compare them in terms of minimum required signal strength, cross-talk, susceptibility to environmental errors and information efficiency.

Much of the material presented is based on the authors' experience and research, and there is a useful bibliography.

°Relaxation Properties of Steels and Superstrength Alloys at Elevated Temperatures

Compiled by ASTM-ASME Joint Committee. Philadelphia, American Society for Testing Materials, 1956. 97p., $4.00 (U.S.).

Tables and graphs give relaxation strengths for low-alloyed Mo, Cr, and V-bearing steels; 12 per cent Cr type steels; a number of super strength alloys, and cast iron. Residual stresses for relaxation to 100, 500, 1,000 and 10,000 hours are used as the main measure of relaxation strength, and the temperatures covered range from 750 deg. to 1100 deg. F. with data at 1200-1500 deg. F. for super strength alloys. The tables also give chemical composition, heat treatment, mechanical properties at room temperatures, and limited creep data.

Résolution numérique des systèmes d'équations linéaires

L. Couffignal. Paris, Eyrolles, 1956. 178p., 2000 fr.

The wide use of mathematical calculations in the solution of the engineer's, architect's, and technologist's problems necessitates a working knowledge of various systems of calculation. This publication expounds the system of the numerical solution of linear equations, which is a method that may be used to solve problems that are not solvable by ordinary calculus. Contents include: definitions and notation, method of reduction to tables, formal solution of linear equations, and numerical solution of linear equations. Illustrated examples and tables are included.

°Roll Design and Mill Layout

R. E. Beynon. Pittsburgh, Association of Iron and Steel Engineers, 1956. 178p., diagrs., $5.0[illegible] (U.S.)

This book traces the development of rolling from early times to the present and deals, from the practical viewpoint of the designer, with roll pass design and mill layouts, with roll manufacture, basic principles of rolling, and for the rolling of blooms, billets, slabs, bars, rods, rails, beams, channels, and angular sections.

°The Running and Gating of Sand Castings: a Review of the Literature

R. W. Ruddle. London, Institute of Metals, 1956. 183p., diagrs., $3.75. (Monograph and report series no. 19)

A critical review and summary of research on the flow of metals in gating systems, carried out in order to determin[illegible]

how to minimize defects in castings. Types of defects, experimental methods, and elementary hydrodynamic theory are dealt with in the first three chapters. The various kinds of gating systems are discussed in detail in the next three chapters, and the last chapter presents conclusions and suggestions for future research. A mathematical treatment of relevant hydrodynamic theory is given in the appendix.

Russian-English Dictionary of Nuclear Physics and Engineering

D. I. Voskoboinik, ed. Moscow, Academy of Sciences of the USSR, Institute of Scientific Information, East Orange, N.J., Associated Technical Services, 1955. 350p., $10.00 (U.S.)

This dictionary, besides covering the fields of nuclear physics and engineering, also covers subjects pertinent to these fields when nuclear phenomena and their effects are involved: chemistry, biology, medicine, geology, electronics, and mathematics. There are 8,000 entries defined in concise and idiomatic English.

Scatter Propagation, Theory and Practice

I. Kamen and G. Doundou'akis. Indianapolis, Sams, 1956. 197p., illus., $3.00 (U.S.)

The principles and uses of scatter propagation are presented in this publication which covers ionospheric and tropospheric propagation, and the equipment and installation of microwave systems. Examples of the work done in this field by the Collins, General Electric and Marconi companies are given in illustrations and circuit diagrams. Test techniques are included and there is a chapter describing northern radar installations.

***Sewage Treatment, 2nd ed.**

K. Imhoff and G. M. Fair. New York, Wiley, 1956. 338p., illus., $7.50.

This standard text provides the sanitary engineer with the essential practical information needed for the design and operation of sewage treatment plants. Such general considerations as costs, plant location, and works equipment are briefly discussed, and the various methods of treatment common in American cities and industries are dealt with fully. New processes covered in this edition include step aeration in the activated sludge process and continuous loading and unloading of sludge digesters with thickened sludge.

Soldering Aluminium Cables

L. Roullier, comp. London, Aluminium Union Ltd., 1956. 83p., illus.

Compiled by a member of the Engineering Institute of Canada, the purpose of this book is to discuss the soldering of aluminum as applied to insulated cables.

The characteristics of aluminum stranded conductor and the nature of the soldering problem are reviewed briefly, following which the jointing techniques using organic fluxes and reaction fluxes are covered. The jointing of aluminum sheaths is discussed in the final chapter. Included in the appendix are current rating tables and factors, as well as a list of suppliers of fluxes and solders.

Statistical Tables on Aluminium, Lead, Copper, Zinc, Tin, Cadmium, Magnesium, Nickel, Mercury and Silver, 43rd issue, 1946-55

Frankfurt an Main, Metallgesellschaft Aktiengesellschaft, 1956. 219p.

This compilation contains detailed statistics on the production and consumption of the principal non-ferrous metals. Historical data covering very early years (B.C.) until 1945 are given in the preliminary section, followed by 1946-55 averages for each metal; a world survey; comparison of production and consumption by continent; statistics for each country by individual metal; and price averages. The tables are clear and comprehensive.

La Stratégie dans les actions humaines

J. D. Williams, translated by Mme. Mesnage. Paris, Dunod, Montreal, Fomac, 1956. 287p., $6.80 (Fomac)

A "primer on the theory of games and strategy" this book presents a comparatively little-known subject in non-technical form. The game theory may be applied to any situation containing a conflict of interests, from games played at home to war. The only type of mathematics used in the examples given is simple arithmetic, and the tone is humorous throughout. The English edition, entitled *The Compleat Strategyst*, is also available in the library.

Stress Corrosion Cracking and Embrittlement

W. D. Robertson, ed. New York, Wiley, 1956. 202p., illus., $7.50

The proceedings of a symposium held in 1954 under the auspices of the Corrosion Division of the Electrochemical Society, the fourteen papers cover the major developments of the last twelve years in the field of stress corrosion cracking and embrittlement. A great deal of work has been done on the problem in the years since the symposium held in 1944 by the A.S.T.M., and A.I.M.M.E., as can be gathered from the lists of references accompanying each paper.

Among the topics covered are: the structure of grain boundaries; the role of boundary absorption in stress corrosion cracking; the mechanism of chemical cracking; stress corrosion cracking in aluminum alloys, homogeneous alloys, a magnesium alloy, austenitic stainless steels, and mild steels.

The papers are indexed.

Structures

P. L. Nervi. New York, Dodge, 1956. 117p., Illus., $6.95. (U.S.)

A designer of reinforced concrete structures for over forty years, Pier Luigi Nervi is architect, engineer and builder, and also the inventor of a new construction material, Ferro-cemento. Using this material, Nervi was the first to build large prefabricated thin shells, and he also used it to make forms which revolutionized flat slab design.

In this book, Nervi presents his ideas on the art of building correctly, and discusses his approach to structural problems and the schemes and materials he has used for their solution, including Ferro-cemento. There are many photographs showing his works both in construction and completed.

The book is translated by Mario Salvadori, a professor of civil engineering at Columbia University, and his wife. He has also written an introduction.

Le Styrène et ses polymeres

H. Gibello. Paris, Dunod, Montreal, Fomac, 1956. 273p., illus., $9.15.

The chemical composition, manufacture and polymerisation of styrene are treated in this book, as well as the many characteristics and applications of polystyrenes. Methods of polymerisation are discussed and uses of the resulting products according to their characteristics; for example, injection molding, coloring and decorative uses, and industrial applications. Contents include: preparation of styrene, analysis of styrene, chemical properties, polymerisation, applications of polystyrene, injection molding, and compression molding.

Trigonometry Refresher for Technical Men

A. A. Klaf. New York, Dover, 1946. 628p., $1.95 (U.S.)

The subjects of plane and spherical trigonometry are conveniently presented in this book, designed to be of service in the solution of problems in navigation, surveying, eleasticity, architecture, and various fields of engineering. Part one covers plane trigonometry including trigonometrical functions, equations, logarithms, and the use of the slide rule; part two covers small angles, periodic functions, and vectors, while part three covers spherical trigonometry.

***VDI-Wasserdampftafeln (Steam tables), 4th ed.**

Sponsored by Verein Deutscher Ingenieure, ed by E. Schmidt. Berlin, Springer-Verlag, 1956. 109p., DM 15.

In this new edition the temperature range has been extended to 800 degree C with a pressure range to 300 atm. The three sections of the tables are as follows: state of saturation (temperature table); state of saturation (pressure table); values of volume, enthalpy, and entropy for water and superheated steam. The large, folded Mollier diagram is in a pocket at the back. The foreword and the explanatory introduction are given in three languages, German, English, and French.

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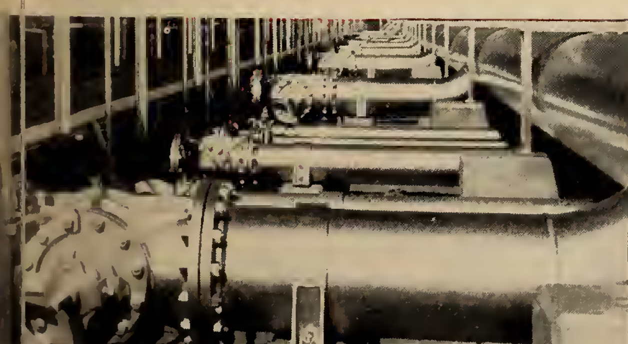


ENGINEERING CAREERS

Machinery and Manufacturing Industries

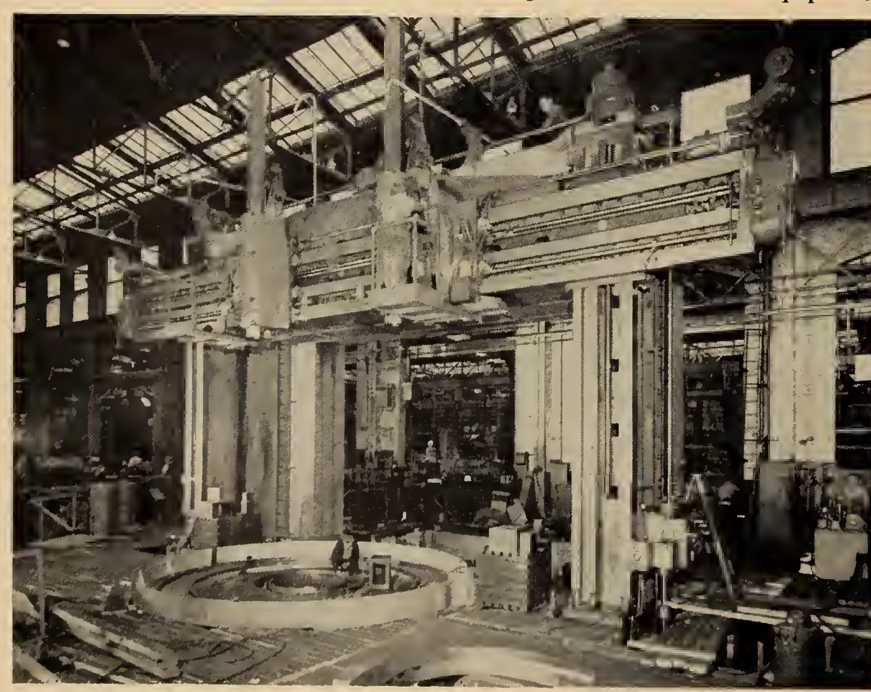
The activities covered by the title of this article are very varied. They are largely associated with the secondary industries.

Canada's primary industries include the exploitation of the country's great resources of minerals, including petroleum and natural gas; forests, pulp and paper; and the general development of transport and communications. Certain large or specialized industries, such as chemical, metallurgical, and heavy metal-working and engineering are dealt with elsewhere from the point of view of what they may hold in store for the engineer who may be planning or starting his career.

To meet the needs of other industries as well as the goods and services that are a part of everyday life, there is this secondary industry. There has been criticism that Canada has tended to neglect secondary industry by concentrating on the development of her natural resources and so having to import many manufactured goods that might just as well have been made in Canada in the first place. There is certainly plenty of room for expansion in these manufacturing fields, especially as the population grows, but there are good indications that this expansion is well under way.

For British Columbia alone, it is estimated that employment in manufacturing, other than the primary industries, will increase 90 per cent in the next ten years. At least similar rates of expansion might be expected elsewhere, particularly in the more industrialized provinces such as Ontario and Quebec. Another authority lists some eighty new industries, classed as important developments, which were established in Canada in 1956. Major developments and expansions of manufacturing industries in the same period are numbered in the hundreds. All this will mean an increased demand for engineers.

Among the larger varieties of machine tools used by the manufacturing industries is this 25-foot vertical boring and turning mill with a table capacity of 300,000 pounds. Engineers are responsible for the design and use of such equipment.



What are the Industries?

It is only possible here to give a few general examples of the types of manufacturing industry in which the professional engineer may look for a career. Of these the widest scope is covered by the heading "machinery".

Machine Tools—In this field one may start with machine tools, since these are the implements with which much of the other machinery and manufacturing equipment and products is made. The actual production of machine tools in Canada is not a very large industry, though it has shown some interesting developments. The use of machine tools by industry in general is on a very wide scale. The tool engineer has an important job in helping to develop new methods, increase rates of production from existing equipment, and adapt techniques to the processing of new materials, to give but a few examples. More specifically, productivity and perhaps quality at the same time might be increased by changing from drilling to a broaching technique in a manufacturing process. The metallurgical engineer is another who is considerably concerned with machine tool operations.

Industrial Machinery—Modern industry tends more and more to use machines rather than manual operations. The handling of materials is made easier, and high production rates made possible, by the use of cranes, lift trucks, conveyor systems and similar equipment. Automatic canning and bottling machinery is widely used in the food and drink industries. Few industries are now without some form of automatic pack ging machinery. Many parts are produced in finished form from the starting raw material, without human intervention, by automatic machinery. The manufacture of all such machinery is itself the work of several industries who may specialize in certain fields. The design of this equipment is largely done by engineers with the machinery-manufacturing companies.

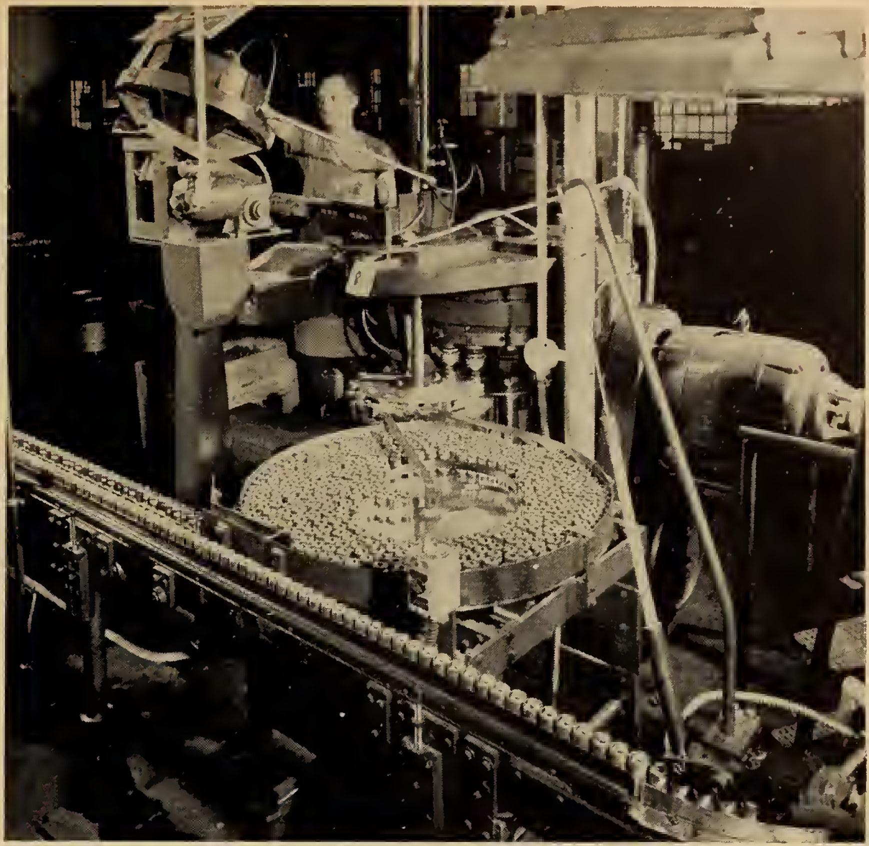
On the other hand, the industries that use this machinery in their manufacturing processes frequently have their own engineering departments who may be called upon to design, develop or improve the production equipment and methods. As a plant expands there is often need to improvise in linking existing and new facilities or it may prove economical to adapt present machinery to a different production role rather than invest in entirely new equipment.

Even in cases where a manufacturer does not normally contemplate the employment of his own staff for the engineering of plant extensions and major modifications, there is frequently the necessity for an engineering staff to maintain the efficiency of the plant. The proper use of planned maintenance engineering is of great importance, both practically and economically, to the manufacturer, especially as machinery becomes more complex and its capital cost higher. Plant and maintenance engineering are therefore both important fields in the manufacturing industries.

Mobile Equipment — Agriculture has long been a major contributor to Canadian economy. The production of agricultural machinery, such as tractors, soil tilling implements, and harvesting equipment, is a correspondingly active industry in Canada and one which makes wide use of professional engineers.

Heavy earth-moving equipment, bulldozers, graders, and so on, are very extensively used in Canada, especially in opening up new areas for development, and engineers are concerned with their design and manufacture, though this is not yet on a very large scale in this country.

Other Industries — Among other industries may be mentioned the manufacturers of plumbing, heating, refrigerating, and ventilating materials and equipment; pumps, valves, and fittings for handling a variety of materials in many different industries; hardware; stationary engines and compressors; household goods



Typical of machinery used in the mass-production of small items is this section of a production line that turns out some 60,000 flashlight batteries a day.

such as cleaners, washing machines, stoves, and even kitchen utensils, which are often made by mass-production methods and represent a large industrial investment.

The rubber industry, textile manufacture, wire and cable production, are other examples of industries that are largely dependent on efficient machinery for their activities, and all have need of engineers. The modern fishing industry is an example of a traditional activity that is turning to engineering to keep it competitive, by using new refrigeration and processing techniques. Other food processing industries are also actively concerned with engineering of plant and production facilities. It is among these industries that there are many openings for chemical engineers.

Opportunities

Among all these varied industries there are some, even those with substantial investments in plant and machinery, that do not specifically employ professional engineers. Others may have very small but specialized engineering staffs. The machinery industries may employ high proportions of engineers. In all, though the demand varies widely, there is always the opportunity for the professional engineer with the right qualifications to progress to the upper administrative and management levels of most industrial undertakings. Though there may be a preponderance of mechanical engineers in the field, engineers of all categories are in demand.

Many of the companies considered here employ sales engineers.

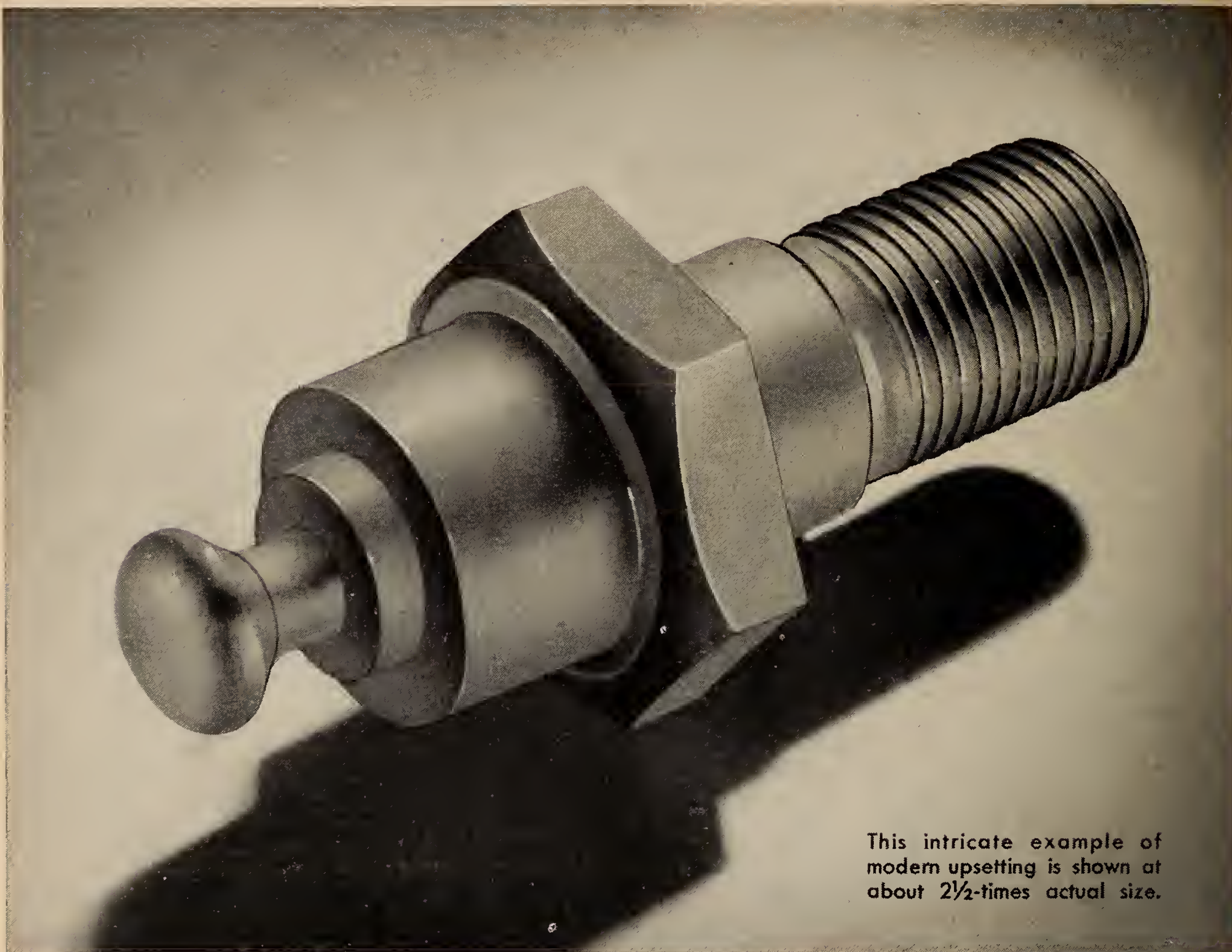
Training

The extent to which training facilities are provided also varies considerably between the different industries considered here, though adequate further training is customary to familiarize the engineer with his new work. Many companies extend these facilities, for example, to financial support of special courses.

Salaries and Benefits

Because of competition for the services of engineers, most industries tend to offer starting salaries within a comparable range. Subsequent advance depends on the individual.

The majority of Canadian industries in which engineers are employed offer the usual benefits of paid vacations, assisted pension and health schemes, and others.



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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

Contents - April 1957

(18,650 copies of this issue printed)

A Message from the President

IT HAS BEEN my pleasure to meet many of you during recent months and on most occasions there has been an opportunity to discuss Confederation. I have attempted to keep the membership informed about the action of Council with respect to this very important matter and, in addition, the *Journal* of July 1956 carried a statement on Confederation.

It has come to my attention that some members seem to believe that the Institute has been stalling, holding back or otherwise discouraging the work towards Confederation. Nothing could be farther from the truth. I hope that a plain simple account of what has happened will illustrate clearly that the Institute is strong for Confederation, and has taken every step reasonably possible to push it forward, and will continue to do so.

Recently the Council of the Institute proposed that I should write to every member, in order to impress them with the Institute's policy on this important matter, in the hope that, in this way we may overcome some of the negative opinions to which I have referred.

May I reaffirm my personal conviction that Confederation is a matter of utmost importance to the engineering profession in Canada. Furthermore, I believe that the Institute will, and should, continue to press for action. I have every reason to assume that the same feeling prevails in the other organizations. So far as I am aware there is no question that cannot be resolved with benefit to the profession at large. I also believe that this project is of such importance that sufficient time should be allowed to build wisely and well for the future.

If you will read regularly the Month to Month section of the *Engineering Journal*, you will be kept informed of developments as they occur. This is the one sure means of following not only Confederation but all the business of the Institute. Your Council and the Confederation Committee have stated that they will move ahead as rapidly as possible and will not be responsible for any unnecessary delays. We hope you will be patient until a final recommendation is ready. We can assure you that as far as Council is concerned and the committee also, there will be absolutely no delays that can be avoided.

A committee was established by Council on April 30, 1954, under the chairmanship of Dr. R. E. Heartz. On his election to the presidency, Dr. I. R. Tait was made chairman on March 25, 1955. This committee has been in close touch with a similar committee set up by Dominion Council. There has been splendid accord between the two groups, which resulted in the preparation of a joint report for the consideration of the Institute and Dominion Council.

The joint report was presented to the Council of the Institute, to the Branch Officers' Conference and to the Annual Business Meeting, during the Annual Meeting in Montreal in May 1956. The report was approved unanimously on all three occasions. It was then sent to the Dominion Council for consideration at their Annual Meeting in June 1956. Dominion Council sent it to each provincial registration organization for study and report.

It is evident that the Institute can take no further steps until Dominion Council have received the reports from the provincial associations, and reported back to their own committee. It is our hope and expectation that they too will accept the joint report as a basis for further study. When that approval has been received it is expected that a joint committee will be created to prepare a detailed proposal. From then on I am confident that rapid progress will be made towards the much desired goal of Confederation.

In the meantime each of you can help by boosting for Confederation on every possible occasion.

V. A. McKillop, M.E.I.C.
President

A Brief Report on the

McGill Coal Burning Gas Turbine Project

D. L. Mordell, M.E.I.C.

Head, Department of Mechanical Engineering, McGill University

An extension of a paper read at the 70th Annual General and Professional Meeting of the Engineering Institute of Canada Montreal, May 1956

IN 1949, the writer suggested that gas turbine engines could burn coal if they operated on what is now known as the exhaust heated cycle.[1] In this cycle, compressed air is heated indirectly in a heat exchanger prior to expansion in a turbine. The hot turbine exhaust air is heated further by combustion before giving up its heat in the heat exchanger. Such a coal burning engine offered a prospect for better generation of electric power and for a locomotive which should be cheaper to operate than the Diesel engine. It was clear, however, that there was at that time insufficient knowledge for the design of any prototype power plant.

In considering the possibilities of such a design, the choice of compression ratio, turbine inlet temperature, heat exchanger pressure loss and thermal ratio presented no problems and analysis by the usual thermodynamic methods could be employed to calculate the obtainable performance, and to obtain an optimium design from a thermal and economic viewpoint. However, there were a number of problems for which solutions were lacking and the writer at that time suggested that a research unit should be built to prove the general principles of the exhaust heated cycle and to study solutions to the following problems, among others.

(*a*) Accurate metering and feeding of coal.

(*b*) Combustion of coal at elevated temperatures.

(*c*) Ash handling.

(*d*) The possibility of fouling or corrosion of the heater tubes.

(*e*) Permissible temperatures in the heater.

(*f*) Optimum mechanical design of the heater.

(*g*) The best materials to use in the heater.

(*h*) The magnitude of the heat losses.

It was clear that once information has been gained on these problems, and assuming that the solutions were practical, it would be possible to design a coal burning gas turbine with every expectation of success.

The writer suggested that the research unit should be built around an existing design of aircraft gas turbine, since this could save time and money, and for this preliminary investigation the actual thermodynamic performance of the gas turbine itself was irrelevant.

This paper is a short description of the work done from the inception in 1949 to the end of 1956 on the project to develop a gas turbine engine that could burn coal as a fuel. Operating on the exhaust heated cycle, such an engine could offer advantages for locomotives or electric power generation.

The writer was introduced to the Federal Department of Mines and Technical Surveys by the late Mr. W. A. Newman, former manager of research for the Canadian Pacific Railway, who believed in the possibilitics of a coal burning gas turbine locomotive. Mr. S. W. Fairwether, vice-president of Canadian National Railways, was also interested in this possibility, and with this support th Department entered into a contrac with McGill University, under whicl an experimental test unit would b designed and constructed under th direction of the writer.

Construction and Test Program

The original program called for u to design and construct the experi mental unit and the necessary facil ities for its testing at an estimate cost of $167,000. The Fuels Divisio of the Mines Department were t test and develop a cyclone furnace t obtain preliminary information for th furnace design. The experimental uni and test facilities were completed i November 1953, at a cost of abou $300,000. The increase over the esti mate was due to the following:

(*a*) The estimates were low.

(*b*) The inflationary effect of th Korean war.

(*c*) An extended strike at a sub contractor's works

(*d*) It was essential to build an test a furnace[2] in our own laborator to extend and supplement the test made by the Fuels Division, whicl were suspended due to unforesee circumstances before much was ac complished.

It was anticipated that about 1,00 hours testing would be necessar which would take about two yea and would cost $200,000. The pro gram called for about 300 hours test ing in the first year, after which i was expected that modification would be introduced, to be followe by 700 hours testing in the secon year. The first part of the prograr

:tually took seventeen months, the ⸱lay being due to the fact that un-:pected troubles relating to the ⸱e of an aircraft engine as a test ⸱hicle took six months to solve, due the large amount of time required strip and reassemble to test the ⸱cessary improvements. At the end the first period it was clear that a ore extensive rebuild than had ⸱en anticipated was desirable. To ⸱rmit this the contract was amended permit the test program to cover ⸱e extra time involved in the rebuild bout six months) and the extra ⸱st.

Results of First Test Program

The results of the first program hich terminated in March 1955 ⸱ve been described in considerable chnical detail in Refs. 3 & 4. They ay be summarized as follows:

(a) It has been amply and ade-⸱ately demonstrated that the ex-⸱ust heated cycle is a practical way burn coal in a gas turbine.

(b) The unit has shown itself to robust and rugged in operation. has been handled throughout by ⸱echanics and testers with no prev-⸱s experience of gas turbines or ⸱rnace equipment. It has survived, ⸱fely, accidents in operation that ⸱ould be likely, in other types of gas ⸱rbines, to cause extensive dam-⸱e.

(c) The maximum power taken ⸱m the machine was 280 horsepow-⸱ compared with a design predic-⸱n of 500. This discrepancy was ⸱e to excessive pressure losses. ⸱ese were higher than the design estimates because at the time of the design, precise information was not available (no similar heat exchanger having been constructed hitherto). Correct information has emerged from the tests.

(d) In any plant of this type experience shows that mechanical teething troubles will be encountered. Our own mechanical troubles were few; in fact, they were virtually confined to one part of the plant, and were not fundamental to this type of gas turbine. Although the troubles were few, considerable time was occupied in correcting them due to the time factor involved in making modifications.

Turning specifically to the questions raised in the introduction:

(a) The original coal feeder was a vibrating type. This was replaced in turn by a compressed air ejector, and by a screw feeder. At the end of the program the screw feeder had shown good results, although further development was needed.

(b) The cyclone furnace showed that it could burn the coal at high efficiency. It was found that a tendency to form cinders, and so cause a deterioration in performance, could result from small changes in type of coal entry. In the arrangement tested, the cooling water losses were higher than desirable.

(c) Ash handling gave much trouble. Numerous arrangements of slag drain removal systems were tried and by the end of the tests it appeared that many aspects of the problem were clear.

(d) On the whole, there appeared to be little tendency for dry fouling of the heater tubes. Serious corrosion was experienced and was shown to be due to the effects of high sulphur content of the coal upon the Nimonic alloy used in the tubes. Small scale work by the Mines Branch helped to elucidate this problem.

(e) It was found that with the particular coal used, the maximum acceptable temperature of the gas entering the tubes was about 1850° F. Attempts to run at higher temperatures led to slagging of the tubes.

(f) It was found that the mechanical design of the heater could be improved a lot. In particular, the tests showed that the gas tube heater was subject to troubles that should not occur in an air tube heater. The cooling losses were high and the pressure loss was high. Determination of the exact values and their correlation permits more accurate design in the future.

(g) It was clearly demonstrated that Nimonic was an unsuitable material to use with sulphur-bearing coal in a gas tube heater. Small scale corrosion tests of numerous alloys were made by the Mines Department and it was suggested that other and cheaper materials could better withstand the attack.

(h) The heat losses were excessively high. Careful analysis showed that losses from the furnace amounted to about 26% of the heat added, while the total losses from other sources were 14%, making a total

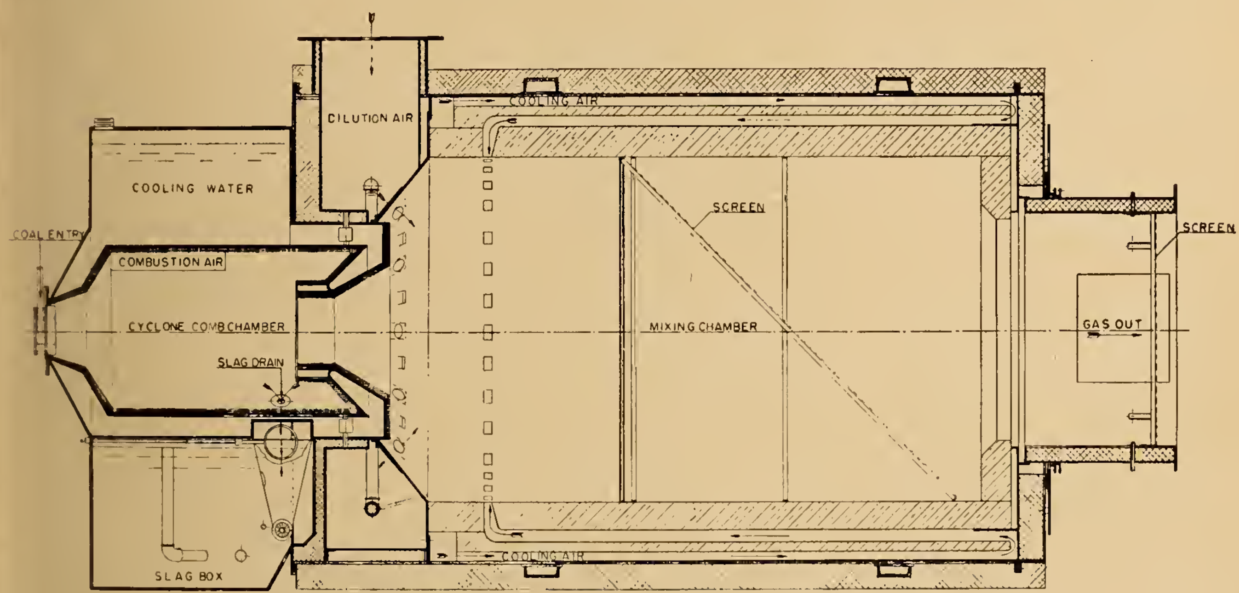


Fig. 1 Cyclone combustion chamber of exhaust-heated coal-burning gas-turbine.

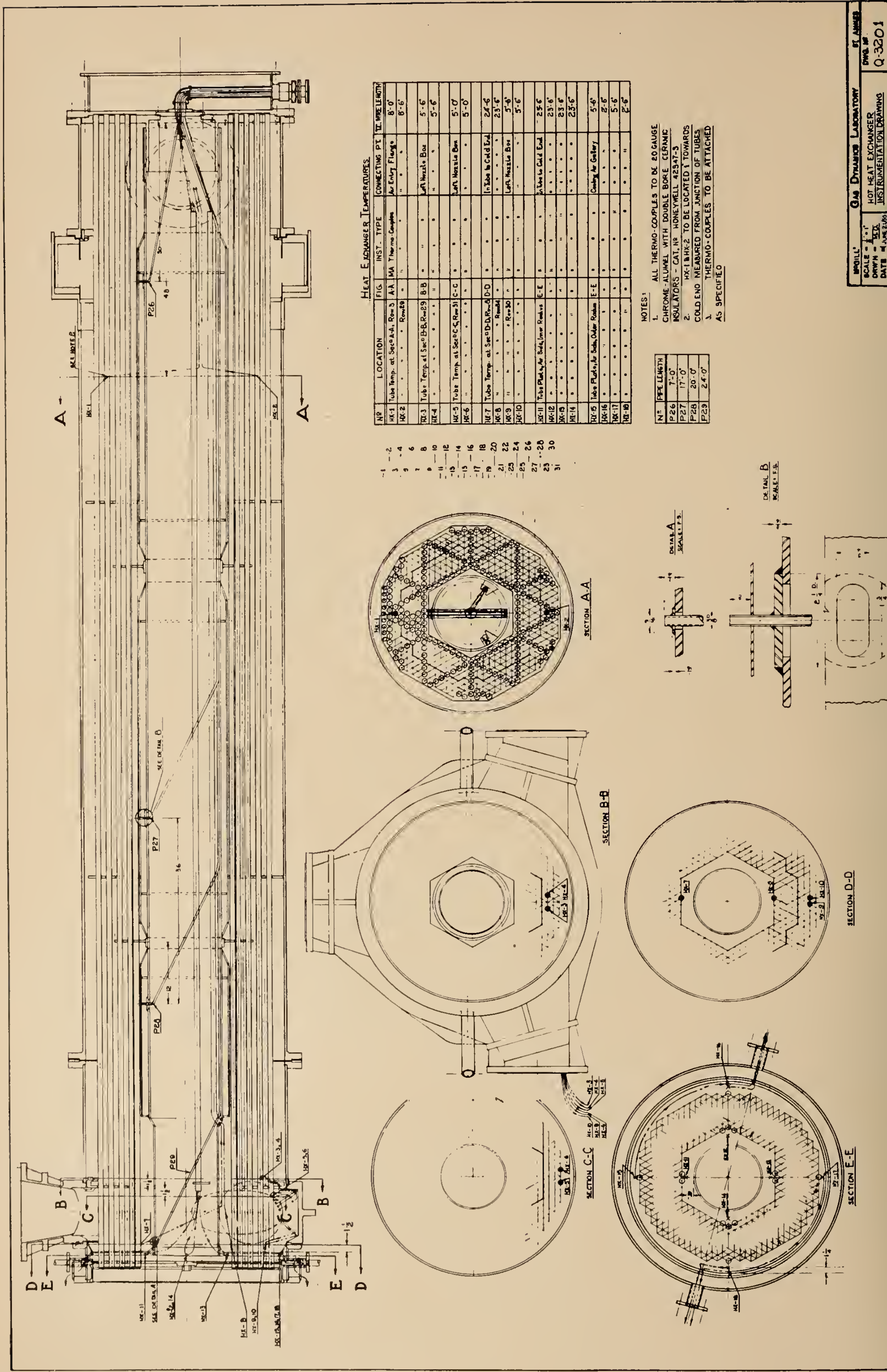


Fig. 2. Sectional views of the rebuilt heater.

loss of 40%. Study showed that in a new design it should be possible to reduce these to 10% and 2%, for a total of 12%. This is accepted as reasonable since the greater part of these losses would go to the cyclone cooling water and not, in fact, be wasted.

Modifications to the Plant

Towards the end of the first series of tests it was possible to review many of the results mentioned above and as a result the decision was taken to stop the tests and make some modifications. These were confined to the furnace and heater. A new design of furnace (Fig. 1) including all the information gained was put in hand in the expectation that heat losses would be reduced, slag removal facilitated, and carry-over reduced. The heater was rebuilt as a simple counterflow unit using as much as possible of the original material. (Fig. 2). Full advantage of the information gained could not be taken as it was not practicable to rebuild it as an air tube heater. Sets of tubes of twelve different materials were included to get direct comparative performance, and although it was expected that some purely mechanical troubles would develop owing to the difficulty of matching different expansion rates exactly, this was regarded as a small penalty to pay for the information on tube corrosion resistance that will be gained. The information gained from pressure loss and thermal measurements was employed to reduce the losses.

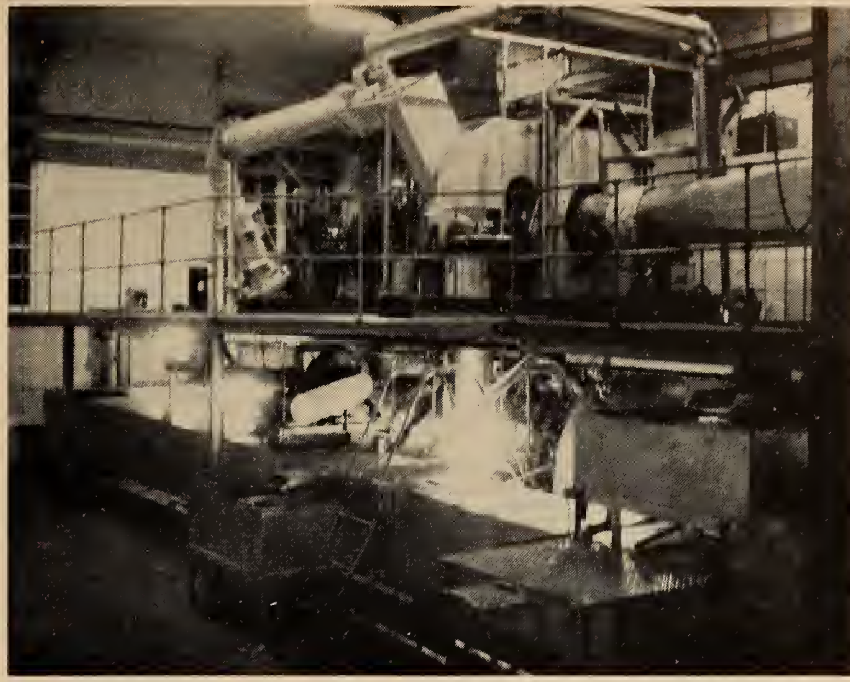
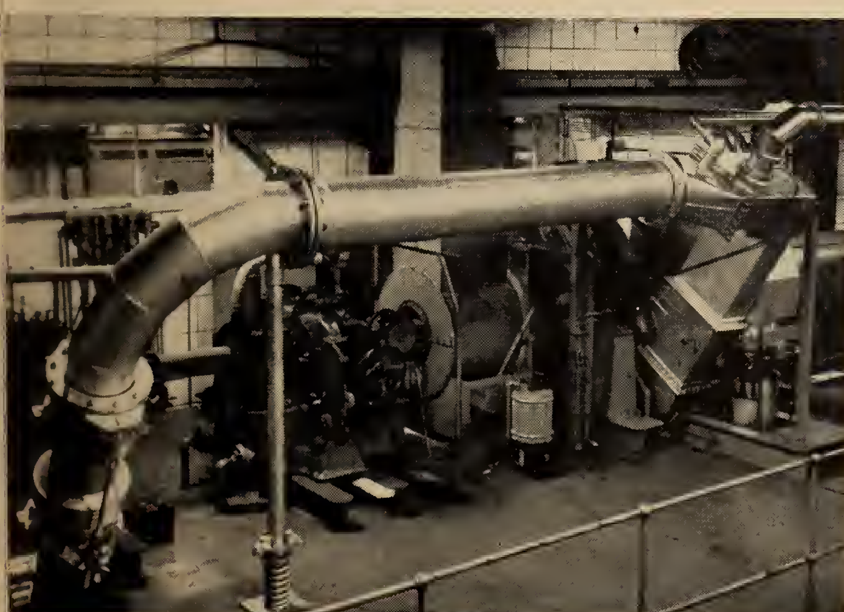


Fig. 3. General view of the rebuilt plant.

In the actual rebuild of the plant, the opportunity was taken to omit one of the original heat exchangers which converted the operating thermodynamic cycle to one which investigation shows is easier to apply in a locomotive than the original cycle. Figures 3, 4 and 5 show the plant in its present arrangement.

During the time in which the plant was being modified, extensive series of rig tests were run on coal feeding screws, slag removal systems, and model heat exchangers. In addition, a detailed estimate of the anticipated performance of the rebuilt plant was carried out.

Fig. 4. View of the machinery line of the rebuilt plant.



Results With The Rebuilt Plant

The rebuilt unit was ready for test on 8th January, 1956. After preliminary "shake down" tests the furnace was modified to give improved slag drainage. At this stage the general performance of the plant was much better than ever before. Exceedingly steady running was achieved, proving that the development of the screw feeder was well merited. The heat and combustion losses of the furnace were reduced to about 15% and the heat losses from hot casings were reduced to about 1%. We still have the loss of about 9% in the heat exchanger tube plate cooling which is inevitable with the gas tube heater. The pressure loss of the heat exchanger agreed with that predicted, and as far as we can tell so far, the performance of the plant is in close agreement with the predictions.

Further minor modifications were made to the furnace as running continued, in order to secure long periods of non-stop operation without continued attention. The initial target of 100 hours uninterrupted furnace operation has now been achieved.

A total testing period of 485 hours has been run in this series, including one run of 102 hours without any interruption or stop whatever. At the end of this period the heater was dismantled to remove tubes for metallurgical examination. Detailed results are not yet complete, but, and most important, analysis of the tubes of type 446 ferrite steel shows no signs of chemical attack, and only slight erosion due to the excessively high velocities necessitated by the plant conversion.

Conclusion

The above is necessarily a very attenuated description of the major results achieved. We believe, on the basis of the work so far done, that we have shown that the exhaust heated machine is practical. Although the cyclone furnace is not the only, nor in some applications, the best type of furnace to employ, we have had good performance from it. We feel that we now know how to design a heater, and what materials to employ, although we recognize that 750 hours of test is no substitute for 10,000 hours of operation.

Our studies of the possible applications, combined with studies of the economics, convinces us that there is indeed a niche for the exhaust heated machine, in which it will be a useful member of the family of prime movers. The only step remaining is to confirm our findings of 750 hours test experience and our studies, by submitting the prototype of an "industrial" engine to prolonged operating conditions.

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(3). An Experimental Coal Burning Gas Turbine; D. L. Mordell, Proc. Inst. Mech. Eng., vol. 169, no. 7, p. 163.

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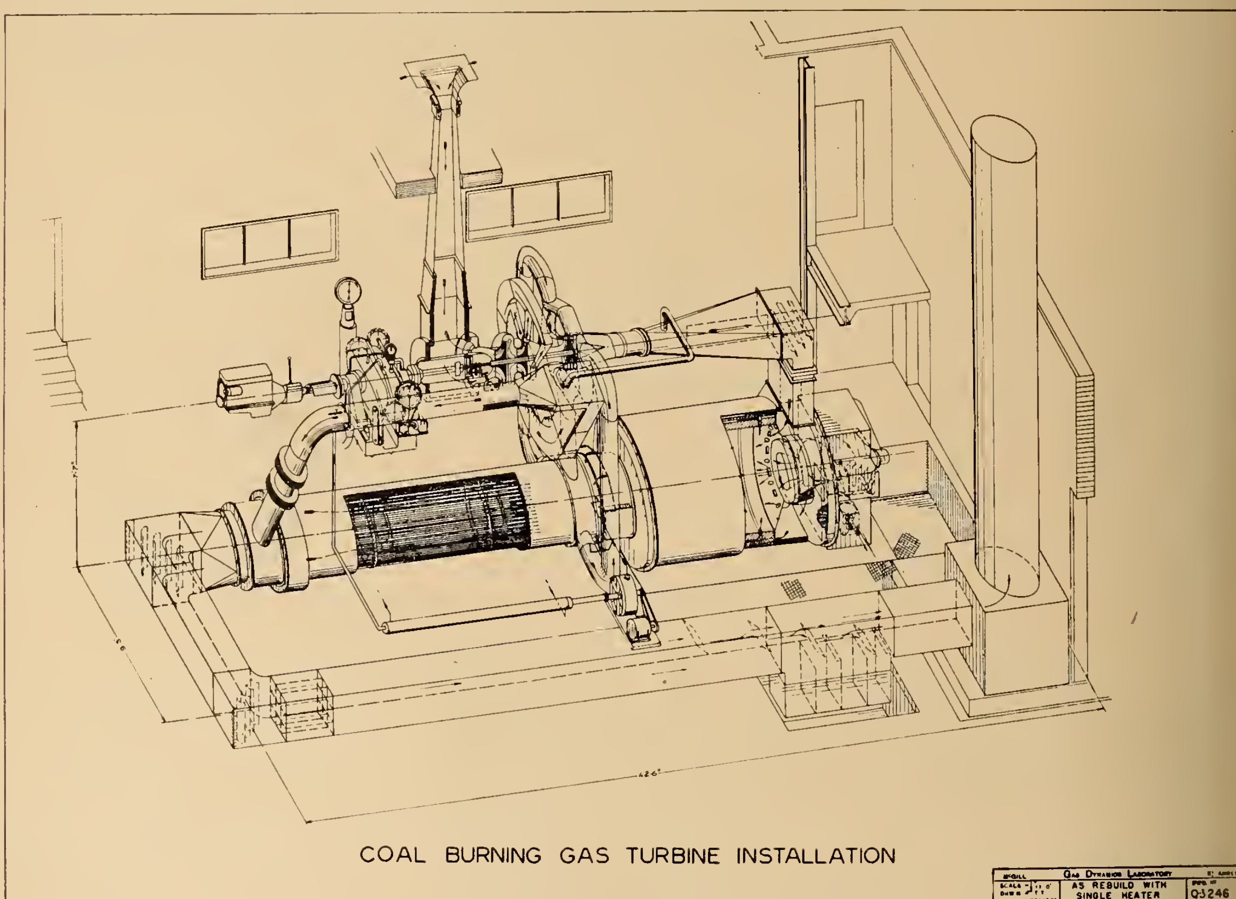
Fig. 5. Diagram of the coal burning gas turbine installation.



The 1957 Annual Meeting

Technical program and other details are on pages 450/451

High Capacity Piles

for the Support of a Large Basilica

J. C. Brodeur, JR.E.I.C.

Spencer, White & Prentis of Canada, Ltd.

The Basilica of Notre Dame du Rosaire, at Cap-de-la-Madeleine, Que., is a large octagonal structure with a 242-foot high eight-sided dome. The walls of the building and the dome are supported by high capacity pipe piles, of sixteen and twenty-inch diameter. The paper describes the installation of the foundations from soil investigations to final testing.

ONE OF THE largest and most complex foundation jobs award-d in Eastern Canada in recent ears was completed by the author's ompany. It is for La Basilique Notre)ame du Rosaire, at Cap-de-la-Made-eine, Quebec, on the bank of the t. Lawrence River; this famous hrine was developed over the years y the Oblate Fathers of Mary-Im-naculate. The basilica will rise on ne former site of the 3000-ton four-ory monastery, which was moved ngeniously on 300,000 steel ball earings some 261 feet to a new te in 1949 by the same foundation rm.

The walls of the structure will be n the shape of an octagon, 175 feet n diameter. From these walls, an ight-side dome will rise to a height f 242 feet. This massive dome will e supported by eight columns, each f which will support 1,050 tons. A luster of piles under each column ill carry the weight some 90 to 100 eet below the ground surface.

Since even a slight settlement of ne structure could mean extensive amage to the dome, the architect, wners, and consulting engineers felt nat the underground work should e handled by foundation specialists ith the experience essential to the roper installation of high-capacity iles. All soil borings, taken at ran-om over the site, clearly indicated ne soil characteristics — a 15 foot and layer underlain by a 75 to 80 oot stratum of highly plastic clay, n turn overlying 8 feet of gravel, and and clay mixture (hardpan) and 2 feet of fissured rock. Due to the existing soil conditions, the heavy loads to be supported, and the nature of the structure, the foundation was designed for twenty-inch diameter pipe piles, loaded to 206 tons, and sixteen-inch diameter steel pipe piles loaded to 150 tons to be driven open-end through the existing soil strata and finally to bedrock. The carrying capacity of the steel cylinders on rock was based on the following formula:

$$P = 0.25\, f_c \times A_c + 9000 \text{ psi} \times A_s$$

Where P = maximum load, lb.

f_c = compressive strength of concrete (28 days)

A_s = area of steel.

A_c = area of concrete

The cylinders consist of electric-welded steel pipe with wall thickness of 0.344 inch driven by a Vulcan No. 1 single acting pile-hammer (5,000 lb. ram, 36 in. stroke), delivering a blow of 15,000 ft.-lb. When the bottom end of a pipe pile had been driven to rock, a small diameter jet pipe, 100 feet long, was lowered into the pipe. With successive bursts of air at 100 pounds per square inch pressure, the contents of the pipe pile were spewed out, with clay often being ejected in fifteen-foot lengths.

As the bottom of this jet pipe approached the rock, water was poured into the pipe pile and again bursts of air through the jet pipe carried up loose rock, gravel and clay, and cleaned the inside of the 100-foot-deep cylinders. Next a churn drill was lowered into the pipe to pulverize the rock for a depth of two feet, creating a socket for the bottom of the steel pipe. In order to seat the bottom of the pipe pile firmly on a clean horizontal rock surface, a series of two or three blowing and re-driving steps was carried out. The bottom of the pile was then visually inspected by the owner's representative on the site, the resident engineer.

At this stage, in several selected locations, a fifteen-foot diamond-drill rock core was obtained from the bottom of the pile. Laboratory tests on these cores revealed compressive strengths of 4,000 pounds per square inch, well in excess of the design load to be carried. With the inspection completed, the pile was then filled to the top with 3000 p.s.i. concrete. Three standard test cylinders were taken from each pour, cured on the job, then sent to the laboratory for testing. The test results, in all cases, exceeded the requirements specified. Concrete was placed continuously and in one operation to prevent cold joints or separation of the ingredients.

Due to the character of the rock, it was not always possible to secure a dry cylinder through redriving. The flow of any material was always stopped, but water leaked into the piles. For such conditions, it was found impractical to entirely remove the water from the bottom of about 30 per cent of the piles, and in accordance with the specifications a bottom dump bucket was used to install the concrete under water.

Prior to any concreting, each pile was checked for location and plumbness. All piles were found to be within the standard practices and tolerances permitted by the specifications; i.e., plumb within two per cent of the length of the pile, and the top of the pile within a maximum of three inches of specified location.

Pipe came to the job in double-random lengths of 45 to 50 feet and sections were joined in the field. Splices were made as the pile was driven, and consisted of external cast steel plate bands or tight fitting sleeves, welded top and bottom to the two lengths of pipe after their ends had been tightly butted together. The splice bands were attached to the lower end of the pieces as the pipe lay in a horizontal position. As driving proceeded and additional pipe was necessary, it was set in the leads and welded to the section below, a skilled welder requiring only 8 to 12 minutes to attach a joint. The low percentage of damaged pipe was due largely to the use of a heavily-framed, rigid pile-driving rig whose operation was directed by experienced men. Great care was exercised to keep the hammer ram always striking exactly in line with the axis of the pile and with the blow centred directly over the pile section.

Due to the physical conditions of the material through which the piles had to be driven, a 12 inch long steel band of the same wall thickness as the pile was welded to the outside bottom of each pile to reinforce the cutting edge.

Table I gives a complete record of piles No. 163 and 118 that were load-tested.

Piles Load Tested

Before continuous pile driving began, one 16-inch and one 20-inch pile were load tested. The piles, designed for 150 and 210 tons respectively, were subjected to a test load 50

Table I. Record of Piles for Load Test

Pile:	No. 163	No. 118
Diameter of cylinder	16 in.	20 in.
Wall thickness of cylinder	0.344 in.	0.344 in.
Length of pile	91.44 ft.	93.33 ft.
Alignment of pile	¼ in. North 2 in. West	½ in. North 1⅛ in. West
Verticality of pile	0.27%	0.40%
Penetration	20 blows/¼ in.	40 blows/1 in.
Strength of concrete after 2 days	4880 psi.	3535 psi.

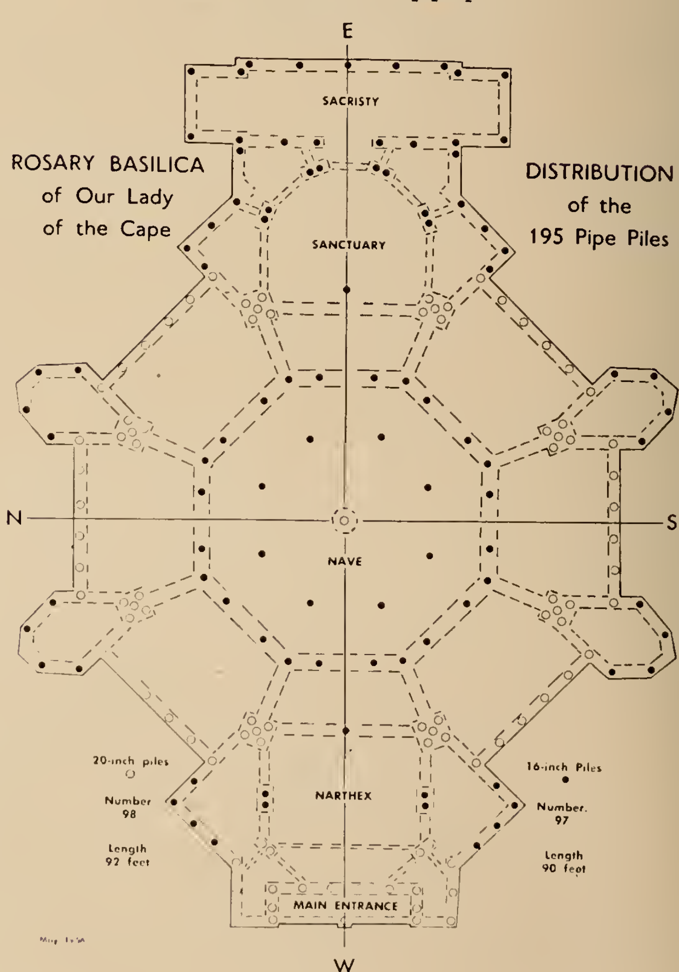
Table II. Load Tests on Piles

Pile No. 163 (16 in dia.)			Pile No. 118 (20 in. dia.)		
Applied load (tons)	Elastic deformation (in.)	Settlement (in.)	Applied load (tons)	Elastic deformation (in.)	Settlement (in.)
225	0	45/64	309	0	37/64
168	4/64	41/64	232	2/64	37/64
112	9/64	36/64	155	9/64	28/64
56	18/64	27/64	77	16/64	21/64
0	36/64	9/64	0	22/64	15/64

Table III. Characteristics and Load Test Results

Pile No.	Dia. (in.)	Design load (tons)	Test load (tons)	Total settlement (in.)	Elastic deformation (in.)	Net settlement (in.)
163	16	150	225	45/64	36/64	9/64
118	20	210	309	37/64	22/64	15/64

Fig. 1. Distribution of pipe piles.



er cent greater than the design ıpacity. To assure accuracy of reılts, two and three 8-inch hydraulic cks were used respectively on the 6-inch and 20-inch pile. Two presıre gauges, checked in the laboratory rior to the load tests and calibrated ı pounds per square inch, were inorporated into the system to asıre further accuracy during the sts, since the maximum permissible ttlement for each type of pile was ot to exceed 0.0017 inch per ton fter corrections for elastic deformaon. This exceeds by far the reuirements of the National Building ode of Canada.

Jack reaction was secured through load consisting of a platform of 48 ieces of 10 in. WF @ 49 lb. beams ach 40 feet long. Next 164 pieces f reinforced concrete slabs, 10 ft. y 3.5 ft. by 0.67 ft. were placed ver the beams. The concrete slabs ad been used previously as runways or moving the monastery and the ontractor was fortunate to have them vailable. The ends of the wide flange eams rested on 12 x 12 timber locking, 15 feet long, resting on the round. Two-inch steel plates were laced on the test pile and on the ıcks. Resting on the top plate above ıe jacks and bearing on the WF eel platform were two 36 inch VF @ 182 lb. beams bolted toether and reinforced with 1 x 4-in. iffeners.

The load was applied gradually nd the settlements observed. Total oad was kept for twenty-four hours nd settlement of the piles was reorded after each hour. Permissible ettlement for the 16-inch pile was 4/64 inch, and 33/64 inch for the 0-inch pile. The total net settlements bserved were 9/64 and 15/64 inch espectively.

Table II gives the results of the oad tests on the two piles.

Grouped in Table III are the charcteristics and the results of the load ests carried out on the two piles.

After a detailed study of the load est results, and when a two-day wait

ig. 2. (top). Left; pipe stock pile. entre; compressor plant layout with air eceivers. Right; pile driving rig driving 0 in. diameter pipe pile.

ig. 3. Left, (background); compressor lant layout. Right, (background); 310 on load test on 20 in. diameter pile 2 ft. long with two ft. anchorage into olid rock. Centre, (foreground); blowıg and cleaning 20 in. diameter pipe ile 92 ft. long.

ig. 4. 225 ton load test on 16 in. diaıeter pipe pile 90 ft. long.

showed no further settlement, the engineers were satisfied with the method and knew that the pipe piles were adequate to carry the loads of the future basilica. Work then proceeded with the driving of the remaining piles in the same way.

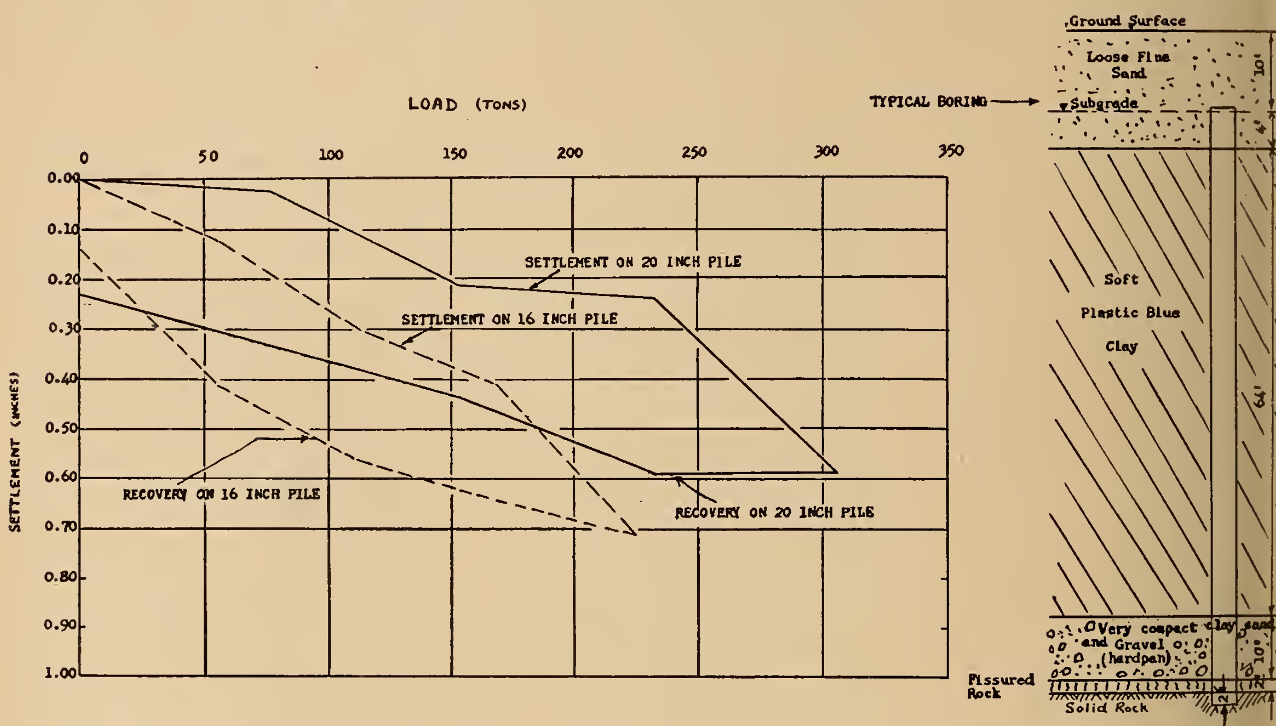
Five 20-inch diameter pipe piles are located in a cluster under each of the eight main piers that will support the dome, and each of these piles supports 206 tons. Additional sections of the basilica will be supported similarly by concrete-filled pipe piles, 16-in. in diameter, each of which will support 150 tons. In all, ninety-eight of the larger and ninety-seven of the smaller pipe piles were driven.

Because of the unusual design, no columns will be visible in the basilica. The nave will accommodate some 2,000 seats, and an additional 6,000 standing can be accommodated in the rear and in the wide aisles. The altar will be clearly visible from every seat.

Acknowledgments

The foundation work carried out for the owners, the Oblate Fathers of Mary-Immaculate at Cap-de-la-Madeleine, Quebec, was under t supervision of architect Adrien D fresne, of Beauport, Quebec, ai the consulting engineers, Survey Nenniger and Chenevert, of Moı real. The resident engineer for t consultants was Jacques Clero Consulting engineers for the mecha cal installations are Tasse, Sarault Associates, of Quebec, P.Q. The e cavation work was carried out by P. Morin Ltée of Cap-de-la-Mac leine. Vincent Fahey was general s perintendent and Harold Ahlberg w in charge of pile driving for Spe cer, White & Prentis of Canada, L

Fig. 5 Pile load tests on 16 in. and 20 in. diameter pipe piles.



Future Annual Meetings

1957

Banff Springs Hotel, June 12, 13, 14

1958

Quebec, Chateau Frontenac, May 21, 22, 23

1959

Toronto, Royal York Hotel, June 8, 9, 10

The Kelowna Floating Bridge

W. Pegusch, Jr.E.I.C.
Swan, Wooster & Partners, Vancouver.

Paper to be read at the 71st Annual General and Professional Meeting of the Engineering Institute of Canada, Banff, Alta., June 1957.

This paper describes in some detail the design and construction of the Kelowna floating bridge, which will cross Okanagan Lake to complete the main north-south route (B.C. Highway 97) through the Okanagan Valley in the southern part of British Columbia. Pictures of the progress of construction are to be shown when the paper is presented at the 1957 annual meeting, and it is proposed to illustrate this progress in later issues of the *Engineering Journal.*

THE KELOWNA floating bridge is being constructed across Okanagan Lake, closing the last gap in B.C. highway 97, the main north-south route through the Okanagan Valley in the southern part of British Columbia. This highway runs from Osoyoos, on the U.S. border, to Salmon Arm, on the Trans Canada Highway. At present the traffic on this highway is mostly local, between the various communities on the lake, with very heavy summer tourist traffic to the Okanagan Valley and to the national parks in the Rockies. However, the highway is a direct connection between the north-western United States and the relatively undeveloped north of British Columbia. Its future importance will probably be directly connected with the growth of this large area.

The present highway, constructed to a very high standard, runs up the west side of Okanagan Lake from Penticton to Kelowna. At Kelowna the traffic crosses the lake on a car ferry and then continues north on the east side of the lake. The new bridge will replace the ferry at Kelowna.

The original report on the Kelowna Bridge, recommended the construction of a suspension bridge or a rockfill causeway rather than a floating bridge. On the basis of costs and aesthetics the design of a suspension span was started. At the same time a thorough subsurface investigation and a programme of aerodynamic stability tests were undertaken. Unfortunately the subsurface investigations, contrary to preliminary findings, indicated that it would not be possible to build a suspension bridge. The foundation material was found to be very compressible and highly susceptible to liquefaction under earthquake loading, a very unsatisfactory type of soil on which to found large piers and heavy cable anchorages. In addition, the shear strength of the material was so low that it could not support a rock fill causeway of the depth required. The final alternate was a floating bridge which derives positive support from its own buoyancy rather than the unstable material of the lake bottom. The lift span over the navigation channel is located towards the east shore where the foundation material is good enough to support the lift span piers.

The entire bridge project is over two miles long. This includes:

(1) One mile approach road, connecting the existing highway on the west side of the lake with the bridge site;

(2) 1400 ft. rock fill embankment out from the west shore;

(3) 175 ft. west transition span between the rock fill and the pontoon section;

(4) 2,100 ft. pontoon section;

(5) 175 ft. east transition span between the pontoons and the west main pier;

(6) 260 ft. lift span;

(7) 175 ft. east approach span from the east main pier to the rock fill embankment;

(8) 300 ft. of rock fill to the east shore;

(9) 500 ft. of approach road through city park in Kelowna.

Pontoon Section

The floating section consists of twelve reinforced concrete units, rigidly connected together, to form one continuous pontoon 2100 ft. long.

The six centre units each 200 ft. by 50 ft. in plan and 15 ft. high, are referred to as standard pontoons. At either end of these are two superstructure pontoons. The lower portion of these superstructure pontoons is identical with the standard type. However, to provide clearance for small boats under the transition spans, the roadway is gradually raised on these pontoons, by means of a steel superstructure.

At either end of the floating section is a smaller 50 ft. by 50 ft. pontoon, on which the draught is increased some 14 ft. to provide the additional buoyancy necessary to

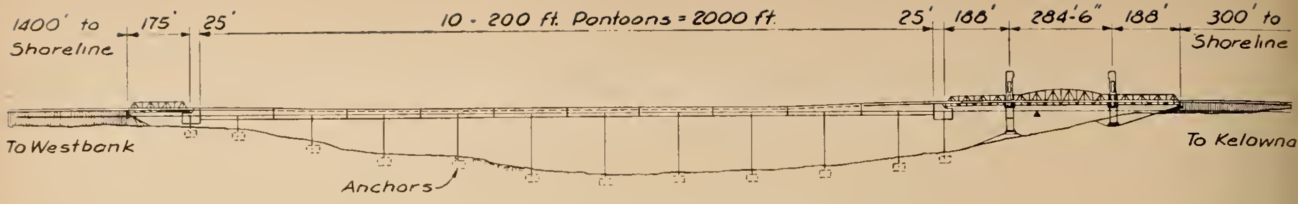


Fig. 1. General arrangement of the Kelowna Bridge showing the floating section and the steel trusses.

balance the dead load reaction of the transition spans that land at the centre of these pontoons.

The pontoons are all held in place laterally by heavy cables, running from the centre of each one to large concrete anchors embedded in the lake bottom. There is a cable and anchor on either side of each pontoon. The entire pontoon section is tied longitudinally to the west shore by a structural steel member suspended from the underside of the west transition span. This steel member is connected to a concrete anchor embedded in the approach embankment.

The top slab of the pontoon provides for a 36 ft. roadway, two 6 ft. sidewalks and two 1 ft. wide solid concrete handrails. Lamp standards, mounting mercury vapour fixtures, are set on top of the concrete handrail.

Standard Pontoons

As noted previously, the standard pontoons are 50 ft. by 200 ft. in plan and 15 ft. deep. The interiors of the pontoons are divided into quarters by three longitudinal walls and then transversely by a series of cross walls. This system of dividing walls forms a total of 56 cells approximately 13 ft. cubes. A group of four cells constitutes a watertight compartment. The four cells of each compartment are interconnected by openings, and access is gained by a ladder and a manhole in the sidewalk.

The top and bottom slabs are 8 in. thick and the sidewalls are 9 in. thick; all interior walls are 6 in. thick. Re-entrant corners are filleted 6 in., except at the intersection of the top and bottom slabs with the sidewalls, where the fillets are increased to 12 in.

The 4 ft. 6 in. solid concrete handrail is provided with a small return at its upper edge to deflect breaking waves down and away from the bridge.

The bottom slab is designed as a two-way slab subjected to hydrostatic pressure and the additional dynamic loading due to wave action. The top slab is also a two-way slab designed for AASHO H20-S16 loading. The sidewalls are designed for the hydrostatic pressure of the water and the pressure due to wave action. A longitudinal ice beam is provided at the waterline to strengthen the side walls against possible ice pressure.

Cables

The lateral loads to the pontoons governed the size and spacing of the anchor cables. Consideration of various factors, primarily possible ice movements, led to the selection of a bridge strand 3.2 sq. in. in area spaced at 200 ft. intervals. This arrangement is sufficient to withstand a wind and ice load of 1900 lb. per lineal ft.

The bridge strand is built up of 90 zinc coated wires 0.210 in. diameter and one centre wire 0.224 in. diameter. The average tensile strength of these wires is 225,000 p.s.i. and the yield strength is about 160,000 p.s.i. The ultimate strength of the completed strand is 350 tons. All completed cables will be prestretched with a load of 150 tons, marked and cut off to length when stressed to 20,000 p.s.i.

The water level in the lake is controlled between El. 1119.0 and El. 1123.0. This four foot change in elevation is accommodated by stretch in the anchor cables. Since the depth of water at the floating section varies between 20 and 160 ft., the anchor cables will vary in length causing different minimum and maximum stresses in all the cables. To make the stress variation in each cable the same, a simple equation was set up relating the cable angle to the depth of water with the particular stress variation selected. The cable stresses were set at 20,000 p.s.i. when the lake is at El. 1119.0 and 70,000 p.s.i. when the lake is at El. 1124.0. This leaves a reserve safety factor in the cables to provide for the exceptional time that the lake level goes above El. 1124.0. The calculated cable angles vary between 8 deg. to the horizontal in the shallow water to 18 deg. in the deepest water.

Cable Attachment

The cables are attached to the cross wall at the centre of each pontoon. This cable wall is divided into an upper and lower part by a slot running the full length of the wall (see Fig. 2). The upper part is 12 in. thick and the lower part 8½ in., enlarged to 12 in. immediately below the slot.

The cable enters the pontoon through the cable port where it passes over the outer saddle assembly. This outer saddle increases the slope of the cable to get it above the water line and in addition accommodates the variation in cable angles. Approximately 6 ft. inside the pontoon the cable passes through the stuffing box and over the inner saddle assembly. The stuffing box will make the cable port almost watertight. Any water that does enter will be retained in the cable well and drained at any time that it is necessary to inspect or work on any of the parts submerged in the well. The inner saddle gives the cable a more horizontal inclination and thereby increases the length of the cable track. The cable socket is then attached to the socket shoe which bears against two plates. These bearing plates are adjustable and can be attached at any point on the cable track.

Saddle Assembly

The inner and outer saddle assemblies are identical except for one cable keeper that is left off the outer saddle assembly. This is necessary since the cables are not tangent to the outer end of that assembly. When the cables are first inserted into the pontoon the cables are bedded in the saddle grooves but not fastened down. The saddles are keyed to the rockers and the cable slides in the saddle groove as the cable slack is being taken up. When the cable is in its final position the cable keepers are installed and the keys removed. Any relative movement that takes place after final positioning will be between the saddle and rocker.

Jacking Assembly

Cables on opposite sides of the same pontoon are installed simultaneously. By careful adjustment of the stress in these two cables, the pontoons are positioned on the bridge centre line.

The cables are stressed by means of the jack bearing against the rear jacking assembly. When the cable has been taken up 3 in. the bearing plates are removed from the cable track and brought up in contact with the socket shoe. The load is then transferred from the jack and rear jacking assembly to the shoe and bearing plates. The rear jacking assembly is loosened, moved up 3 in. and the jacking started again. This operation is repeated until the cable is stressed to the desired amount. The final cable stress will depend on the level of the lake at the time the stressing is done (20,000 p.s.i. at El. 1119.0).

Pontoon Connections

The detail of the pontoon connection is shown in Fig. 3. The two 3 ft. by 3 ft. shear keys, centred on the two intermediate longitudinal walls, are temporary connections to hold the adjacent pontoons in line while the permanent connections are being made. Steel shims are placed around the perimeter of each key to align the pontoons exactly. The pipe sleeves along the bottom and up the sides of the pontoons are tapped and provided with plugs to prevent water from entering while the pontoons are being floated into position.

When the pontoons have been brought together the bolts under the roadway slab are installed and the 1-in. grout space unwatered by removing the plugs from the lower pipe sleeves. The rubber strip at the bottom of Fig. 3 is continuous along the bottom and up the side of the pontoons and seals off the 1-in. grout space. Large ½-in. spacers centred on each longitudinal wall keep the pontoons 1 in. apart while the remainder of the bolts are being installed.

During this phase of the connecting operation all the bolts are just stressed enough to maintain the 1-in. grout space. A non-shrink type of grout is placed through the top of the grout space and the top 2 or 3 inches finished off with an ordinary sand cement grout.

When the grout has set up, the bolts, made from high tensile steel (ASTM A-325), are stressed to 72,000 p.s.i. There is a total of 146 1¼-in. diameter bolts per connection, and when they have all been tensioned to their specified amount we have, in effect, a very short prestressed beam.

Before making the connections with the end pontoons, they have to be ballasted with water so that the end connections will line up. The weight of this water ballast will be equal to the dead load reaction of the steel transition span.

Pontoon Analysis

When the pontoons are all positioned and connected together they will act as one continuous unit 2100 ft. long. This long pontoon, floating in the water, is a perfect example of a beam on an elastic foundation.

The usual problem of an elastic foundation involves the rather debatable and uncertain properties of a soil foundation. However, in this case we have a perfectly elastic foundation; in other words the material follows Hooke's law. A downward deflection of any part of the pontoon increases the buoyancy and produces an upward reaction, proportional with the displacement. Similarly an upward deflection decreases the buoyancy and produces a downward reaction. Of course in this case we are concerned only with displacements and reactions relative to the initial unloaded condition. Hetényi[1] has investigated this theory very extensively and has developed nu-

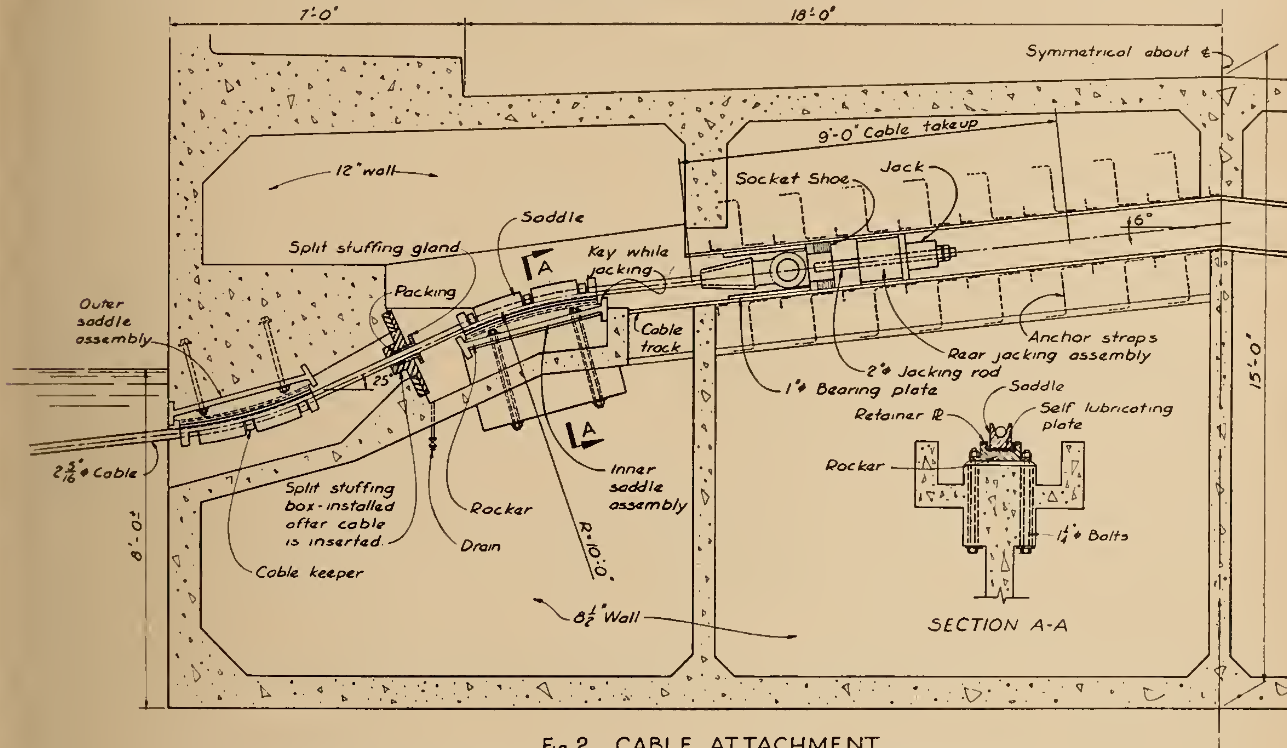


Fig. 2. Cable attachment at the centre cross-wall of each pontoon, showing the jacking assembly and cable saddles. The cable is adjusted with a 100 ton jack.

merous formulae which helped a great deal in analysing the pontoons. Using these formulae, influence lines for moment and shear were set up for 100 ft. intervals along the bridge.

Figure 4 *(a)* shows the pontoon subject to a point load at its centre. The curves *(b)*, *(c)* and *(d)* are, respectively, the deflection, moment and shear. From the examination of the curves of Fig. 4 it can be seen, that if at point 1 a force P_1, and a point 2 a force P_2 are acting, the deflection at 2 due to the load at 1 is equal to the deflection at 1 due to the load at 2, i.e. $Y_{1,2} = Y_{2,1}$. Similarly $M_{1,2} = M_{2,1}$ and $Q_{1,2} = Q_{2,1}$. In other words the curves of Fig. 4 are actually the influence lines for the point under consideration. These curves are used in the centre section of the bridge but are modified, very simply, to investigate points close to either end.

Pontoon Loading

If the weight of the pontoon were uniformly distributed along its length, the dead load would not induce any stresses. However we do have certain concentrations of dead load at the cable wall, end connections and superstructure pontoons. In addition the vertical components of the cable reactions apply a series of point loads to the pontoons. The stresses resulting from these loads were considered as dead load stresses.

Live load stresses were calculated using the AASHO H20-S16 lane loading, with appropriate reductions for loading of multiple lanes.

Because of difference in temperature between the air and water at various times of the year, it was assumed that the temperature of the upper and lower surfaces of the pontoon could differ by 25°. This temperature differential tends to bow the pontoons up or down depending on which surface is at the higher temperature. If the deformation were not restrained, no stresses would be induced in the pontoons, but since the deformation alters the buoyancy along the length of the pontoon, the bowing is restrained and temperature stresses are set up in the pontoons.

The longitudinal forces applied to the pontoon section are taken by a structural tie at the west abutment. This tie is connected about 15 ft. above the centre of the pontoons and hence applies a moment to the end of the pontoon section. We therefore have bending stresses as well as direct tension or compression due to the longitudinal forces.

The combination of ice and wind was the only horizontal loading investigated. This combination is much more critical than the loading due to wind and waves which is the only other loading possible. The ice

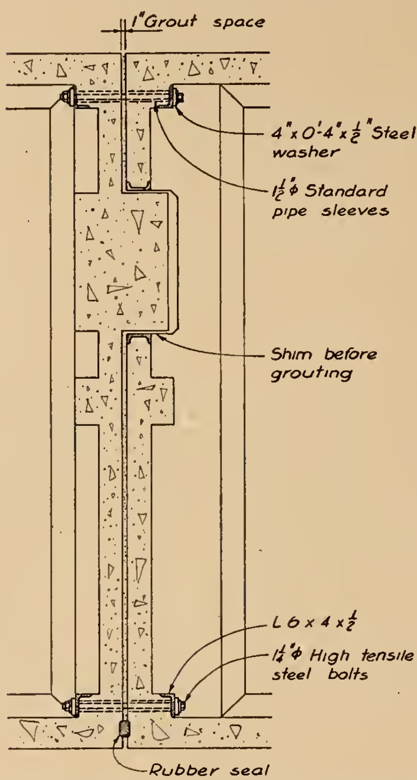


Fig. 3. Pontoon connection showing the 3 ft. square keys and the 1¼ in. diameter high tensile steel bolts.

and wind loading was assumed as a moving load of 300 lb. per lineal ft. due to the wind and 1600 lb. per ft. due to the ice.

Anchors

Each pontoon cable is fastened to a large 20 ft. by 32 ft. concrete anchor embedded in the bottom of the lake. These anchors, as shown in Fig. 6, are rectangular plates with slight folds toward either end and two tapered ribs connecting the plate to the cable fastening. The anchors weigh approximately 70 tons each and are buried 20 ft. below the bottom. Jet pipes are provided along the length of the anchor to assist in the sinking. The anchors are designed to resist the ultimate load that can be taken by the cable. As a check on this design, the first set of anchors will be tested by applying a test load of 220 tons, some 40 per cent over the working load. This test will be made by ballasting one of the end pontoons with water and then making a temporary connection to the cables. The ballast will then be removed to apply the test load to the anchors.

Construction Plant

The pontoons will be built in two graving docks specially constructed for this purpose. The graving docks are located on the east shore of the lake approximately one half mile north of the bridge site. The north graving dock is 60 ft. by 210 ft. in plan, with its bottom 17 ft. below the surrounding ground. The other graving dock is parallel and 200 ft. south. The bottom of this south graving dock is 19 ft. below the surrounding grade.

The sides of the graving dock are allowed to assume their natural slope and the working area kept unwatered with a well-point system around the perimeter of each dock.

The timber bottom of the graving dock is supported on five rows of piles centered under the longitudinal walls of the pontoons. A system of 12 by 12 caps and 4 by 12 stringers on top of the piles are decked in with 4 x 12 planks. These planks will be covered with a heavy building paper and will serve as the bottom forms to the pontoons.

Running along each side of the graving docks are two rows of piles which support a working platform and a runway for the concreting gantry that spans each graving dock. These piles will also be used to brace the outside forms of the pontoon sidewalls.

On either side of the graving dock excavations, provision is made for four 30 ft. crane runways. Mobile cranes operating from these runways will place forms, reinforcing steel and transfer concrete to the concreting gantry. The remainder of the space between the graving docks and two 60 ft. by 200 ft. areas on either side, will be used for storing wall forms.

Concrete Plant

Concrete for the project will be supplied from two 2-cu. yd. mixers. The mixers are part of the completely integrated concrete plant specially set up for this contract. The 150 ton aggregate bin on the concrete plant is charged with a 24 in. belt conveyor. This aggregate bin is divided into separate compartments to store five different sizes of aggregate. Bulk cement will be stored in a 2000 cu. ft. circular silo. Automatic batching equipment will weigh

The five aggregates and cement preparatory to charging the 2-cu. yd. tilting mixers.

The mixers will discharge the concrete into bottom dump concrete buckets, sitting on flat bed trucks, and the trucks will carry the concrete buckets from the plant, to a point opposite the concreting gantry. At that point the buckets will be picked up by a mobile crane and swung over the concreting gantry where the concrete will be deposited into a hopper on the gantry.

The concreting gantry will be of heavy steel truss construction and will travel the full length of the graving dock. Concrete will be transported in concrete buggies from the main hopper at one end of the gantry to small chutes fastened on either side of the gantry. From the chutes the concrete will be discharged through elephant trunks into the pontoon forms.

As the concreting gantry moves along the pontoon, concrete will first be placed in the wall forms to a depth of about three feet. This concrete is placed from the leading edge of the gantry and will spill out through the bottom of the wall forms to a distance of about two or three feet. From the trailing edge of the gantry the remainder of the bottom slab and the walls to the underside of the roadway fillets will be poured. The first concreting operation will precede the second by about 20 minutes. This continuous pour of bottom slab and walls will require about 800 cu. yd. of concrete.

Before the pontoon is removed from the graving dock, the roadway and sidewalk slabs will be placed. Pouring of the handrail and erection of any superstructures will be done at the outfitting wharf when the pontoon has been floated.

Pontoon Formwork

Each graving dock has its own set of prefabricated wooden forms. The formwork for each cell consists of four separate panels with removable bracing at each corner. The corner closure is made with a strip of plywood that forms the fillets at the wall intersection.

A mobile crane is used to install the forms to alternate cells, after the bottom slab steel has been placed. This checkerboard arrangement of cell forms provides support for the wall steel which is then placed.

Each wall panel when it is first installed is supported by linkage bars to two 6 by 6 posts. The forms are supported in this manner until just before the concrete pour is begun. As a final operation the forms are raised about 1 in. by means of small screw jacks attached to the forms and supported on concrete blocks.

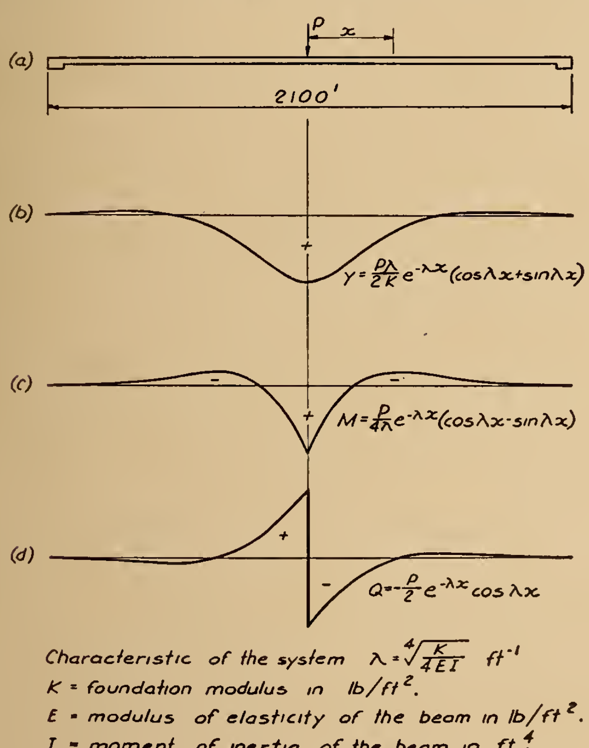


Fig. 4. Beam on an elastic foundation. These curves show the extent over which a point load exerts any influence.

As the forms are raised the linkages fall loose from the 6 by 6 posts and the posts can then be removed.

The panels of the cell forms are removed individually by the mobile crane and placed in the form storage area adjacent to the graving dock. The pressboard form for the roadway slab is supported on a light wooden grillage and four timber posts at the quarter points of the panel. This wooden grillage is collapsible and can be easily removed through the access doors and sidewalk manhole.

Main Piers

The west main pier has a 42 ft. by 93 ft. base which tapers to a 28 ft. by 80 ft. 6 in. section, 7 ft. 6 in. above the bottom. This rectangular section continues up to the second transition 48 ft. above the base. At this point, both ends of the pier are changed to a semi-circular section. This section continues to the underside of the cap. Total height of the pier is 85 ft. 6 in.

A centre longitudinal wall and six cross walls divide the inside of the pier into fourteen 10 ft. by 12 ft. cells. The bottom slab of the pier is 30 in. and all interior walls are 13 in. thick. Sidewalls are 18 in. thick for the lower 48 ft. and 15 in. for the upper section.

The pier will be carried on 390 fifteen-ton friction piles. These 80 ft. long untreated timber piles will be driven with an underwater driver and cut off within ±1 in. When the piles have been cut off, 4 ft. of gravel fill will be placed level with their tops.

The west main pier and the east main pier will be built as floating caissons. The base or launching sections will consist of the 2 ft. 6 in. bottom slab and 5 ft. of the vertical walls. Fastened to this concrete section will be 12 ft. of a 12 by 12 timber cofferdam. This timber cofferdam will provide the free-board required and also serve as the outside forms for the pier sidewalls; 2 by 4 spruce splines between adjacent 12 by 12 timbers will make the cofferdam watertight. The cofferdam is braced with one hundred and twenty-one 31.8 vertical wales in pairs and 12 by 12 timber strutting. The vertical wales run up the inside of the cofferdam and will be embedded in the pier walls.

This launching section will be constructed in the pontoon graving dock. To make this possible without additional dredging the dead weight of the pier is reduced by the installation of 1600 ft. of 14 in. diameter "Sonovoids". The addition of these "Sonovoids" reduces the draught of the launching section by about 4 ft.

The launching section will be floated from the graving dock and anchored at the pier site. Lifts of concrete and cofferdam will then be built until the freeboard of the pier is sufficient to discontinue the cofferdam. Continued construction of the pier shaft, and the admission of some water to the cells, will eventually seat the pier on its foundation. At this point water is to be admitted into the cells to the full height of the pier to preload the foundation. When a stable condition has been reached, water will be expelled from the cells and the remainder of the pier completed. During this preloading operation the piles will be subjected to a larger load than they will be required to carry when in service. When completed, the pier is kept partially buoyant by automatic controls regulating the water level inside the pier.

Except for a slight rearrangement of the interior walls; the east main pier is the same as upper portion of the west main pier. The pier is only 47 ft. high and therefore the rounded section was continued down to the top of the 87 ft. by 36 ft. base section. This pier is considerably shorter than the west main pier and as a result is supported on only 308 piles. In addition the cofferdam used during construction has to be removed since it would be exposed at low water.

A wood pile fender system extending 240 ft. north and south of the east main pier will prevent railroad car barges from grounding in the shallow water behind the pier.

Steel Superstructure

All the steelwork was designed for an H20-S16 trailer truck loading in accordance with the AASHO standard specifications for highway bridges and movable highway bridges with slight modifications for rivet or bolt spacings and thickness of cover plates on truss members. Structural carbon steel was used throughout for main members since the stresses nowhere would warrant the use of higher strength steels. The truss members and connections are designed for rivets or bolts while the main tower members are welded box sections with bolted field joints.

As the towers are the most prominent feature of the structure, they were designed as rigid frames with only one cross bracing frame at about mid-height to eliminate unsightly diagonal bracing. The lifting equipment is completely enclosed in a steel sheathed housing to enhance the tower's appearance.

Generally, the sections of the truss members were governed by the dead plus live plus impact stresses except for the end posts of the approach and transition spans where portals exist. The size of wind bracing members on the lift span and east approach span were generally governed by slenderness requirements, but the wind bracing of the two transition spans was governed by stress for reasons that will be noted later.

Lift Span and Towers

To keep the loads on the towers as low as possible the deck of the lift span was provided with a steel open grid roadway surface and lightweight concrete sidewalks. The open grid deck was supported on longitudinal stringers which are simply supported on the top flanges of the floor beams thereby providing access to the top flange of the floor beams for painting.

The trusses are 41 ft. 6 in. on centre and are of the Warren type with a depth of 38 ft. at the centre panel and 28 ft. at the end panel. The lifting beams are framed into the top joints of the end panels and connected to the counterweights by eight cables at each end of the beam. The beams are four feet deep with heavy webs well stiffened to resist the high shearing stresses. The centre portion of the beam, between lifting cables, has no web since shear is non-existent, but is trussed to support the flanges for moment resistance. The cables are connected by means of sockets to a heavy plate which bears directly on the underside of the bottom flange of the lifting beam.

The truss bearings are designed to carry the dead load only of the span as this load is greater than the live load plus impact. When the structure is in service the only loads on the bearings will be the live loads plus the small portion of the dead load which is not balanced by the counterweight. However, when the structure is not in service, such as during construction or maintenance, it will carry no live load and the bearings may then be required to carry the full dead load of the span for which they are designed.

The fixed bearing is of cast ste and is in two halves; the bearing p being fixed to the lower porti which is anchored to the pier wh the upper portion is connected truss and lifts off the pin when t truss is raised. The expansion be ing is a pin and rocker assemb the entire unit being connected the truss with only the base pl being anchored to the pier. Se lubricating bushings in the expansi bearings allow the rocker to assu a vertical position each time the sp is raised.

Four truss guides each 30 in. de are located at both ends of the sp, one at each of the upper and low joints. At the fixed end of the sp, the truss guides engage a conti ous runner which is bolted to a l extends the full length of the tow leg. The bottom guides at this e resist movement in both a late and longitudinal direction, and t top guides in only the lateral dir tion. At the expansion end of t span the truss guides will resist mo ment only in a lateral direction a will allow longitudinal movement expansion and contraction.

The clearance between the tr guide and tower runners is ¼ when the span is in the raised po tion, but as the span is lowered t clearance decreases to ⅛ in. which point the centre of the e floor beam engages a centring vice which positions the span in lateral direction for accurate se ing on the fixed pin and on the b plate at the expansion end. The tr guides are bolted to the trus through slotted holes to allow fine adjustment in the field.

To reduce impact on the lift sp towers and piers, buffers a attached to the floor beams n each bearing to decelerate the dov ward motion and allow the span settle gently on to the pier suppo. Shock absorbing bearing pads also used under the bearings to f ther reduce impact.

The towers are designed as ri frames in both directions with t legs and struts being of welded pl construction. The design of t frames perpendicular to the bri was governed by earthquake for and dead load at a 33 per cent crease in allowable working str while the frames parallel to t bridge were governed by stres due to 30 lb. wind and dead l at 50 per cent increase in work stresses. The front legs, adjacent the lift span, carry a very high axial load, about 80 per cent of the sheave reaction, but they are the same cross section as the rear legs which carry a smaller axial load but have a much higher eccentricity.

Lift Span Machinery

The vertical lift span will be raised 45 ft. to give a vertical clearance of 60 ft. above high water. The

In order to keep the span as light as possible it was decided to locate the drives in the lift span towers. These tower-drives could be described as counterweight - sheave drives. That is, the bridge is moved either up or down by suitable gearing from the electric motors to the rim of the counterweight sheaves.

The two motors on each tower are coupled to the opposite ends of shaft. The slipping coupling provided will prevent this type of overloading. The slipping coupling will also permit adjustment of the seating of opposite sides of the span. This adjustment will be necessary to compensate for unequal creep or stretch of the lifting ropes and will also be particularly useful when the bridge is being aligned during construction.

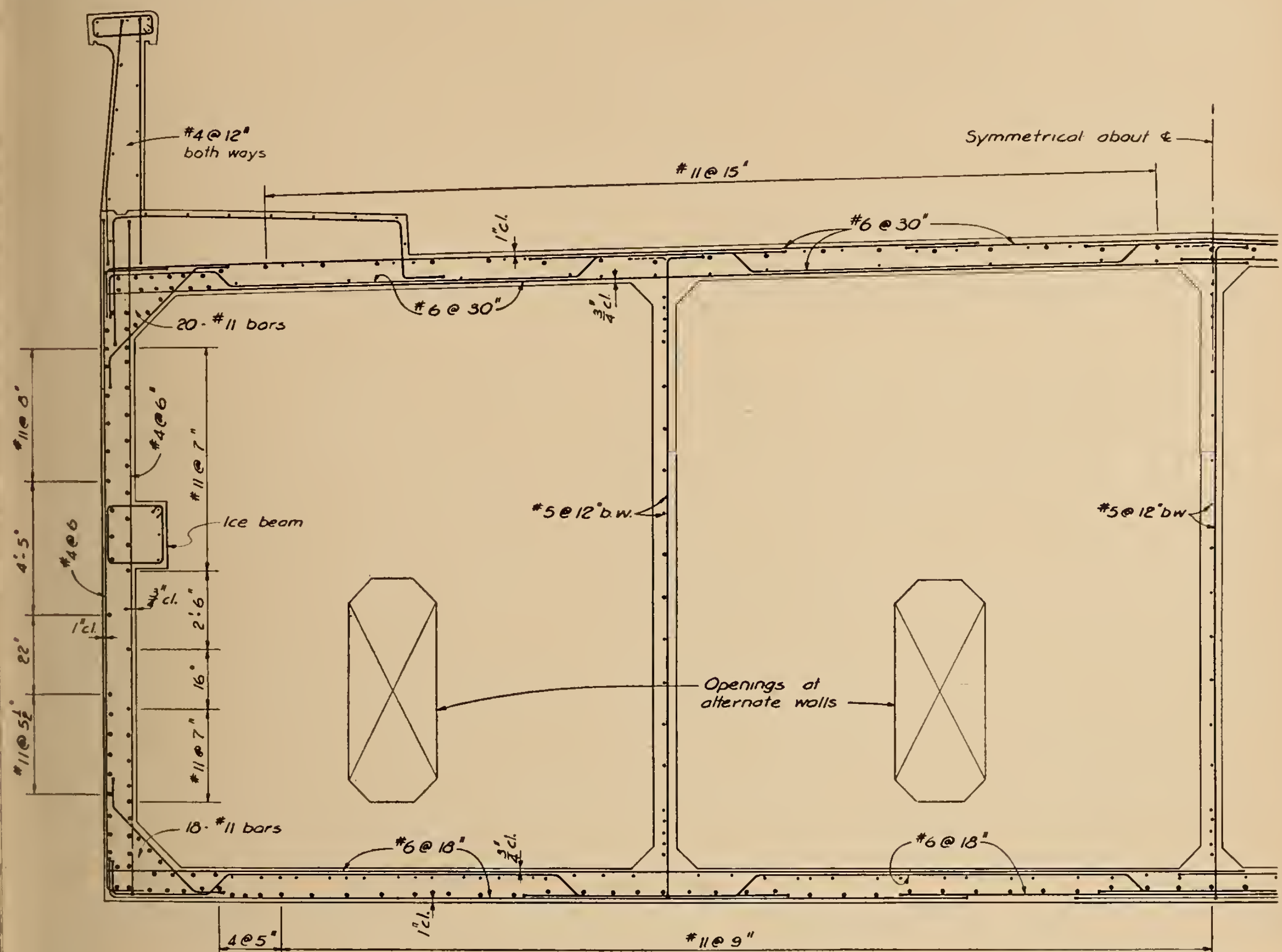


Fig. 5. Typical reinforcing of pontoon section

lift span, weighing approximately 500 tons, is suspended at each corner by eight 2-in. diameter special plough steel wire ropes that pass over sheaves 12 ft. in diameter. These ropes are connected at one end to the cross girder between the top chords of the two trusses and at the other end to the concrete counterweight. The concrete counterweight moves up and down inside the tower and to compensate for the weight of the lifting ropes, a cast iron counterweight chain is fastened to the bottom of the counterweight and to the tower. In this manner the system is balanced for all positions of the lift span.

the high speed shaft of an enclosed gear reduction unit, located at the centre of the tower. The main cross-shafts extend from each side of the gear box to an open gear reduction at their outer ends. A 7 in. diameter intermediate shaft carries the main drive pinion meshing with a ring gear integrally cast with the counterweight sheave.

The main cross shaft carries an overload slipping coupling. Under normal conditions equal power is transmitted to both cross-shafts. However, if one side of the lift span should jam, and the other remain free, all the power from both motors would be transferred to the one

The main cross shaft carries a shaft brake consisting of a 19 in. diameter cast iron brake wheel with spring set, solenoid operated jaws. This brake holds the bridge in the open position against the forces of ice and wind. The brake is normally closed and will only be released when the span is being moved.

The cast steel counterweight sheave, together with its 17 in. diameter shaft, weighs approximately 25,000 lb. The shafts rotate on spherical roller bearings. In fact, roller bearings are employed throughout the design and their use reduced the power requirements by one third.

The wires of the 2 in. diameter

ropes are of special improved plough steel. The ropes are of 6 x 19 construction with an impregnated hemp core. These ropes will be prestressed and cut to length in order to avoid extended field adjustments. Provision is made for small field adjustments to equalize the rope tensions.

The bridge operation is a completely automatic variable voltage tower drive and is controlled by the operator from his station in the east tower, just above the roadway. The opening sequence is started when the operator pushes the button that closes the traffic gate. All other necessary operations follow automatically until the span is in the raised position. The operator again pushes the button to close the bridge and when his panel indicates the bridge is locked in the closed position, he pushes another button to open the traffic gate.

Power is supplied at 440 volts to the motor generator sets in each tower. Each generator then supplies direct current at 230 volts to the two drive motors in each tower. The drive motors are of such a size that the span can be raised or lowered with only one motor at either end operating.

Sufficient indicators and warning lights are provided on the control panel to show the operator that the entire opening and closing operation is proceeding satisfactorily. In particular a selsyn control is provided to indicate and align the position of the opposite ends of the span. This control will disconnect the drives and sound an alarm if the skew becomes excessive.

Transition Spans

The transition spans and the east approach are very similar in side elevation and the main truss members actually carry the same stresses with the exception of the end posts. The similarity ends here, however, and the bracing members, connections, and bearings are quite different on these two types of spans, due entirely to the flexible supports provided by the end pontoons. These supports allow four types of motion: longitudinal, due to temperature, currents, live loads and wind; lateral, due to currents, wind and ice; vertical, due to live load and change in water level; and a torsional motion, due to lateral wind and unbalanced lane loading. The magnitude of these movements is greatest at the pontoon or free end support of the east transition span, the totals being 21 in. longitudinally, 30 in. laterally from the centre line of the bridge, 62 in. vertically, and a torsional movement of 9½ in. from the centre line of the bridge.

The transition spans are designed to allow for all these movements with the main trusses always in a vertical plane. To accomplish this it was necessary to pin the span horizontally

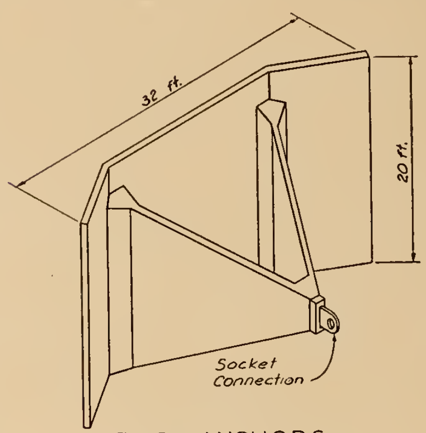


Fig. 6. Anchors embedded 20 ft. below the lake bottom provide lateral stability for the pontoon section.

and vertically by means of a universal pin on the centre line of the bridge at the pier and abutment supports (non-moving) and to allow the free ends of the spans on the pontoons to swing laterally and vertically and make all bearings of the rocker type that would allow longitudinal and torsional movements.

The bearings at the free ends of the two transition spans (pontoon ends) are composed of three steel castings that house two pins, one vertical pin and a universal pin (see Fig. 7). The lower casting is a rocker which rotates on the universal pin, the lower section of the pin being horizontal and perpendicular to the bridge length. The rocker bears on a bed plate to which is attached a toothed rack which meshes with gear plates bolted to the sides of each rocker, thereby preventing longitudinal displacement of the bearing. A cast steel shoe which bears on the upper portion of the universal pin is provided with a vertical steel pin about which rotates the upper steel casting, which is bolted to the truss. The moving contact surfaces are provided with self-lubricating bushings. These bearings thus allow movement in three directions, a longitudinal and lateral rotation about the universal pin and a horizontal rotation about the vertical pin, and therefore satisfy all requirements at the pontoon bearings.

Since these bearings will transmit only vertical loads, it was necessary to provide a special wind anchor to resist the lateral wind loads. The anchor must allow longitudinal movement of the span, horizontal rotation, and a vertical rotation due to the change in grade of the roadway, but it must resist all lateral forces. It consists of a horizontal guide on the centre line of the bridge and is located slightly below the bottom flange of the end floor beam. It is supported at one end by the reinforced concrete end wall of the pontoon and at the other end by two steel legs of a vertical "A" frame. Attached to the underside of the end floor beam is a tongue which slides within the guide, bearing on the side shoulders depending upon the direction of the wind. The sides of the tongue are curved to allow horizontal rotation of the span without interfering with the action of the wind anchor.

The bearings at the pinned ends of the spans (pier and abutment ends) are designed to accommodate only two movements, longitudinal displacement and horizontal rotation about the centre line of the end floor beam. Only one pin is, therefore, required in this bearing and the rocker rotates through a horizontal arc with its centre on the centre line of the end floor beam.

The anchorage at the pinned enc of the east transition span is on the centre line of the end floor bean and consists of steel castings housing a vertical and a horizontal pin which allow horizontal rotation, and vertical rotation due to change in wate level. This anchorage provides resistance to both lateral and longitudina forces.

Roadway Deck

The roadway deck is lightweigh reinforced concrete supported o stringers that frame into floor beam that have a built-in crown of inches. The floor beams are of necessity pinned to the truss vertica to allow for tipping of the pontoon while the sidewalk brackets are fixe to the verticals so that the sidewall always remain horizontal when th roadway is tipped.

Roadway expansion joints at bot

ends of the transition span are the interlocking finger type. At the pontoon end of the east transition span, owing to the large movements to be accommodated, the fingers on the pontoon section had to be horizontally pinned in order that they would not in some cases project above the road surface as the span changed grade. Sidewalk expansion joints are the sliding plate type and it was necessary at the pontoon joint to

span as is the usual case but had to be resisted by a horizontal force in the wind anchor on the pontoon. This introduced additional stresses in the truss members but they were insufficient to change the controlling stress grouping from dead plus live plus impact; except in the end post.

The struts of the top and bottom lateral brace systems, like the roadway floor beams, had to be pin connected to the main trusses to allow

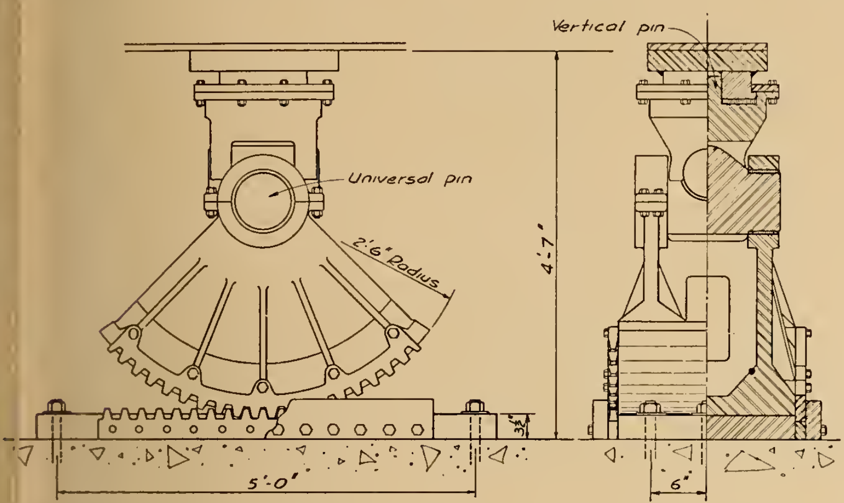


Fig. 7. Rocker bearing at the elastic support, provides for vertical, longitudinal, lateral, and torsional movement.

hinge the top plate diagonally and provide a sliding guide along one free edge to prevent the plate from projecting above the sidewalk level as the pontoon tipped.

Since the pontoon section was not provided with longitudinal anchor cables, the most westerly pontoon was tied to the west abutment by means of a heavy "H" section which was supported by, but not attached to the truss floor beams of the west transition span. The only point at which the tie and the transition span are rigidly connected is at the end floor beam at the west abutment. This tie must resist all the longitudinal forces on the pontoons and the west transition span.

Wind

Wind on the transition spans could not be dealt with in the conventional manner because of the absence of a portal frame at the pontoon end of the span. The top lateral system was designed as a cantilever truss supported at the pinned (or pier) end of the span. The couple required at the bottom end of the portal frame to balance the cantilever effect could not be offset by an equal couple at the other end of the

for the pontoon tipping. At the same time, the diagonal braces had to be connected in such a manner as to transmit to the main trusses the longitudinal component of their stresses. At a typical top lateral brace connection, the diagonal and the strut were connected with horizontal gussets to act as a unit and the strut was then pin connected with a horizontal pin to the side of the chord member. A built-up tongue, rigidly connected to the brace strut, was projected over the top of the chord member and fitted to bear between two shoulders fixed to the chord members.

Twisting of the pontoons introduced some difficulties in the connection of the lateral braces since the warping of the plane of bracing tended either to shorten or lengthen the diagonal braces varying amounts. If the members had been proportioned so they would not change length they would have been larger than any of the main truss members and would have tended to hold the low-side bearing off the pontoon when it tipped. Consequently, the diagonals of the bracing system were connected with slotted holes of varying lengths depending upon the distance of the connection from the pinned end of the span to allow the trusses to follow the rotation of the pontoons without introducing extremely high stresses in the bracing members.

Slotting of the diagonal brace connection holes to allow for warping in the plane of the brace system results in the end posts of the pontoon ends of the spans moving out of plumb not more than 1⅝ inches in a vertical distance of 28 ft., an amount that would hardly be visible to the naked eye.

Personnel

The bridge project is being constructed for the British Columbia Toll Highways and Bridges Authority and will be operated by them as a toll bridge. The contract for the approach roads and rock fill embankments was completed in August, 1956, by General Construction Company of Vancouver, B.C. The contract for the abutments, main piers and the floating section is being carried out by Kelowna Bridge Contractors, a joint venture of General Construction, of Vancouver, B.C. and the sponsors, Pacific Bridge Co. of San Francisco, California. Mr. Emerson Hail is project manager for Kelowna Bridge Contractors, Mr. Chris Andersen, general superintendent, and Mr. T. B. Coull, Jr., project engineer.

The contract for the steel superstructure will be let in April, 1957, and, subject to the availability of structural steel, the bridge should be completed in the summer of 1958.

Swan, Wooster and Partners, consulting engineers, Vancouver, are the designing and supervising engineers for the whole of the work. The assistance of Mr. C. E. Andrew of Seattle, Wash., and designer of the Lake Washington Floating Bridge, is gratefully acknowledged. Mr. D. C. Gough is resident engineer at Kelowna for Swan, Wooster and Partners.

The writer has been in charge of the design of the pontoons and the substructure for the steel work. Acknowledgment is made of the assistance given to the writer by Mr. W. V. Coventry, who was responsible for the design of the steel superstructure and Mr. H. F. Wooster, M.E.I.C. who supervised the design of the entire project.

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Who Caused the Engineer Shortage?

G. L. Wilcox

President, Canadian Westinghouse Company Limited

Address to The Engineering Institute of Canada, Hamilton Branch, January, 1957

IT IS EXTREMELY important for me and for my company that in speaking to you I attempt to answer honestly the question posed in the title: "Who caused the engineer shortage and what can we do about it?"

Engineers these days are a problem of a peculiar sort to the industrial manager. On the one hand they are desperately needed — not only the engineers already in the organization, but more as well. On the other hand, there is a continuing question as to how engineers should be dealt with in the organization; how to provide them with the best possible conditions for efficient functioning.

The shortage of engineers has now reached a point where an industrial manager hardly dares send them out to recruit other engineers. One company in the U.S. recently sent seven engineers to a technical convention to see if they could recruit from among those in attendance — and five of the seven just never came back. They had been recruited by other company scouts at the same convention.

In Canada, the engineer shortage is beginning to have serious effects in many areas. In our own field the pressure seemingly is not quite so great as it was, but the shortage still exists. The enrolment of young people in engineering schools is increasing, but not as fast, by any means, as the estimated demand. There is certainly good evidence that the engineer shortage will be with us for a good while to come. In fact, it may be that there never again will be a surplus of engineers in this country.

As to the causes of the shortage, on reflection I have come to the conclusion that no single factor is to blame. A great many of us have played a part in this situation. First and foremost among the causes, of course, is the engineer himself. He has brought about the shortage by being so successful. If the engineers had not been able to show us how important and valuable they can be in industry, there would be no more shortage of engineers now than there was in the 1920's and 1930's. But the world, thanks to the scientist and the engineer, is quite a different place today than 30 or 40 years ago.

It is a world based on technology —on competitive technology between industries, between sections of the country, and between countries and vast political "spheres of influence". The key to success in almost any enterprise these days, little or large, is engineering.

The engineer has made a very large place indeed for himself in the modern world — a place so large that there just aren't enough engineers available to fill it.

For this — as a primary cause—the engineer has himself to blame.

But from there on, the difficulty has been compounded by almost every factor in our economy. The root difficulty has been failure to foresee, in recent years, where the furiously burgeoning development of technology in industry, warfare and daily life was leading us.

Among the institutions that seriously failed to foresee and prepare for the great change were o schools, colleges and universitie Though many voices were raise and many fingers pointed, the scho system in Canada as well as in tl United States continued in its tr ditional pathways, turning out gra uates of about the same kind ai with the same basic preparation f their lifework as in the previo twenty years or more. Meanwhile tl demand for engineers mounted.

Those who support the schools (should support them) including ta payers, businessmen, foundatior private donors and the like, we equally at fault. Money becan available too slowly to provide f the necessary expansion in the scho system. There is still too little mon to catch up with the demand, ev for bricks and mortar and physic school facilities.

As to teachers — their salari were allowed to fall far behind t economic procession. Many of t best of them left the school sy tem to seek better-paying jobs el where. So, when we began c manding more and better enginee we found that through our natic al and economic short-sightedness v had starved the schools of the mea of supplying our needs.

Finally, in the front row of cc tributors to the engineering shorta I put business and industry itself. F we in industry have been lagga in finding the best ways to use o engineers. If industry had been de ing with a *material* that was simil ly in short supply, you may be su the research laboratories and en neering departments would lo ice have found ways to make every pecious ounce of it do full duty, and ne of it would have been wasted applications in which its unique alities were not needed.

In the case of scarce engineers, wever, we have tended to use m in the traditional, wasteful ys inherited from the days when re were plenty of them — when gineers, in the minds of many in- strial managers, were just another m of white-collar worker.

In investigating this, we are apt to e in almost every industrial com- ny numerous cases of mis-employ- nt of engineers — that is, engi- ers doing non-engineering work; o many instances where able en- neers are being prevented from ing their best, or accomplishing as ich as they are able, for lack of itable trained technicians, general sistance or other personnel and fa- ities.

Key Positions

I am not referring, of course, to ose numerous instances where en- neers are satisfactorily filling super- ory or management positions. aduates of university professional urses will always continue to fill y positions in many fields other n those of their specialties.

Professional graduates are almost variably men of high intelligence d multiple capacities, and after aduation some of these talents de- lop faster than others, frequently anging a man's role in life radical- l Some of our best industrial man- ers are men who formerly were en- neers — and I hope I may be par- ned if I say that this is a tendency t should be encouraged, rather n otherwise.

When I speak of the mis-employ- nt of engineers, I mean those in- nces where a man, prepared for gineering, is now engaged in work a non-managerial nature that does t require, or in many instances en make use of, the special train- g that goes into engineering. Such e of engineers is often sheer waste. results too often from careless nagement, failure to appreciate special values of engineers, or glect. The net result is that both lustry and the engineer fail to get most out of professional training d talent.

In our own company we have en studying the problem of mak- g better use of engineers for some ne. Our surveys have disclosed gineers doing time study, serving as order clerks in the pricing de- partment, engaged in minor rede- sign of equipment that could just as well have been done by men of lesser training. We have found engineers as- signed to such jobs as converting drawings from the metric system, or revising stock order numbers on Kar- dex cards.

We have not been alone in com- mitting such sins. In the United States, particularly, surveys have shown similar situations.

Fabian Bachrach Photograph

G. L. Wilcox, President, Canadian Westinghouse Company Limited.

In a recent study of several var- ied industries reported in the maga- zine *Machine Design*, engineers were found to be engaged in at least 75 non-engineering jobs and occupations. These jobs ranged all the way from draughtsman to checker, estimator, plant maintenance man, core-room supervisor, traffic analyst, technical writer, and tool room foreman.

If engineers are being used to any great extent on jobs of this kind throughout the continent, no wonder there is an engineer shortage! But equally bad, I think, is the rather common industrial practice of failing to give a creative engineer adequate help.

Often a large part of his time must be used uncreatively, in making drawings, checking computing and the like — tasks that could as well be handled by technicians or others specially trained for these specific jobs. Their education and training would not need to be nearly as ex- tensive as that of an engineer.

In dealing with this aspect of the engineer shortage, industrial manag- ers could do worse than to study the ways in which our better hospitals make use of trained surgeons and doctors. In such hospitals, the high- ly trained medical man or surgeon does not use any of his time or ener- gy in making beds, tying bandages, handling bedpans or serving meals. Such tasks are well and efficiently handled by well-trained specialists, technicians and nurses, at consider- ably less cost than if the doctors were to do them, even assuming that there would be enough doctors to go around. By this intelligent dividing up of the job among several kinds of trained workers, the highly skilled medical men are released to per- form, at high efficiency, in precise- ly those areas where only they can accomplish the necessary result.

In some parts of the continent, I understand, school systems are now also experimenting with this same kind of division of labour. In many schools there is a teacher shortage, just as in industry there is an engineer shortage. In the experi- ments to which I have referred, trained technicians are being used to assemble the students, call the roll, set up educational paraphernalia such as charts, motion pictures, dia- grams, etc., and the teacher comes in only to teach. His time is thus re- lieved of non-teaching chores. The results of his efforts are thereby not only improved, but more students can be taught by fewer teachers.

What Can Be Done?

Now, what can be done about the engineer shortage?

These observations have already pointed one way in which industry can help. There is also another step that industry can, and must, take, and which we at Canadian Westing- house have been trying to implement in recent months. This is the recog- nition of engineers as a special group, a sort of *third estate*, in the indus- trial organization. The purpose is to give the engineer status; and with it, increased opportunity to perform ef- fectively.

Until quite recent years it has been natural to think of industrial or- ganization as consisting primarily of two groups or classes. On the one hand was "management", often in- cluding the owner or owners. On the other hand, there were the "employ- ees"; the people who did the manual work, tended the machines, and car- ried out the accompanying clerical tasks.

In this conceptual scheme no place was left for the engineer or other professional man. They had to be lumped off with the so-called "employees", and dealt with on the same basis. Nowadays, when everybody in a large company is, in a very real sense, an employee — including top management itself— some of the old distinctions between "management" and "employees" are melting away.

But in any effective form of industrial organization, there still must be those who make the vital decisions (the so-called "management") and those who carry out the decisions (the so-called "employees").

But engineers — and several other types of professional people such as accountants, lawyers, industrial relations men — are not really either "management" or "employees" in the usual sense. Their function is creative or advisory. They are especially prepared, for a special function, by special training and education. They are set out from others also by their special talents and creativity.

You will recall that in feudal England there were traditionally three classes, or "estates", among that part of society having political rights. These were the Lords Temporal, or the ruling class; the Lords Spiritual, representing the church; and the Commons, the latter being the great class of landowners from whom sprang so much of the strength of the English state. Without carrying the analogy too far, it seems to me we must realize that in industrial organization there are now also three estates: the management, the non-managerial employees, and the professionals.

Professional Men

As I have already implied, the term professional must not be taken here as applying only to engineers. Any major business enterprise today makes use of a small army of professional men of many kinds. In addition to engineers, they include the professional men in research, law, purchasing, accounting, industrial relations, public relations, advertising, manufacturing, sales and service. Of these, in most manufacturing industries, the engineers are probably the largest group — and, at least from some points of view, the most important.

Proper recognition and status for these professionals will not, of course, create any more of them. In that sense, it will do nothing to overcome the immediate engineer shortage. But it will, I think, make the professionals we have more effective. And, in the long run, proper status for the engineer in industrial organization will help to make engineering a more attractive and satisfying career, helping to attract to the engineering profession many young men who today might choose against it.

A path of increased recognition and status must, of course, consist of greater financial reward; greater opportunity to earn commensurate with ability and productiveness. A good engineer ought not to have to go into some other line of work, for example, management, solely for the purpose of making an adequate living. If he is a good engineer, he ought to be able to earn as much in engineering as he can in any other way.

The Right Job

At Canadian Westinghouse we believe that a person will always produce at his maximum potential when he is doing the job that he likes to do best. Therefore, we try to see to it that the question of more pay alone will not be an inducement for him to change jobs or status.

A successful professional engineer in Canadian Westinghouse can now earn a salary that approximates that of a successful manager — and he can certainly earn more than many supervisory people. Moreover, we try to see that the other forms of prestige that a professional enjoys in the company is also equal to that of a manager.

In all this, we do not believe we are unique. Many other companies are undoubtedly developing along these same lines. As this kind of thinking progresses, the engineer's estate will become more and more satisfying and more and more creative.

None of these measures by themselves will end the engineer shortages, and end or alleviate it we must, if we are to continue to enjoy our present high standard of living, and at the same time keep ahead in the international race for survival in which we find ourselves engaged.

In winning the rest of the battle we need a grand alliance, a concerted effort, among all the forces involved: industry, the schools, the government, the taxpayer and the engineers themselves.

Industry can do far more than it has been doing, I am sure, in stimulating the interest of young people in engineering careers. Last fall, as yo know, a number of industrialists an educators from all parts of Canad assembled at a "National Engineer ing Manpower Conference" sponsore by A. V. Roe Canada Ltd., to dis cuss this problem and to take actio on it. Some of the things suggeste at that conference, and some of th activities stemming from it, will un questionably have far-reaching e fect.

Industry and Schools

But in addition, industry mu give more support to the school must refrain from competing wit the schools for technical personn who are needed to teach; must co tinually press for more adequate f nancial support for the schools, s that the facilities will be adequa for training, and above all, so th the kind of salaries can be offered teachers which will attract the be of them for the vital job of teachir the nation's forthcoming crop young engineers.

Industry, the schools and govern ment must stimulate and encoura more fundamental research, as we as the training of engineers. The e gineer's function, as I see it, is tl translation of fundamental scien into practical applications. But if tl stream of new scientific knowled slows to a trickle for want of suitab support, or dries up, the engineeri achievements will ultimately slow as well.

Research of this kind can best l carried on in other types of esta lishments especially set up for tl purpose. Some types of fundamen research can be done also in ind trial laboratories; but by and lar the best fundamental research done in laboratories that are free publish their full results, and to p sue their investigations to the e regardless of commercial conside tions.

It seems to me, finally, that a la part of the cure of the engineer sh age depends on the very people w started it all in the first place — engineers themselves.

I have pointed out that if the gineers had not been so success in transforming the face of the e nomic and industrial world th would not be any engineer short today, or for that matter, any dem for engineers whatsoever in indus

But they have been successfu successful beyond any possible dre that our ancestors could have h

The present unprecedented era of widespread material wealth and prosperity can only continue so long as the engineers keep up the rate of progress, not only through new discovery and invention, but also by the continued enhancement of man's productivity. Having aided so much in increasing the productivity of all mankind in recent years, the engineers must now address themselves to increasing their own efficiency and productiveness.

As Winston Churchill has said in quite another connection, "Never have so many owed so much to so few". The human race owes much indeed to the few thousand creative engineers who have brought about the present era of productiveness and plenty. But the few will always remain relatively few — no matter what we may do. For in a very real sense, the scarcity of engineers is only a special manifestation of the general scarcity of brains.

Psychologists say that it takes an I.Q. of 125 or better to produce a good professional man, in any professional field. Only about 10 per cent of the whole population have an I.Q. of this magnitude. Upon this precious 10 per cent (about half of whom are going to devote themselves to motherhood, no matter what) the world must depend for all its professional developments of the present and future. Thus, engineers will always be precious and few. We must find ways to make every one of them count; and this is a responsibility for the engineers, as well as for the managers and the rest.

A Special Problem

In Canada, we have a special problem. Our precious engineering talent tends to leak away, most especially across the porous border to the south, where wages are high, opportunities great, and temptations mighty. We cannot close that porous barrier directly, nor would we want to, for the engineer must be free to seek his fortune wherever he can most readily find it. But we can close the border, in effect, by equalizing the conditions — as one might stop osmosis through a membrane by putting the same solution on both its sides.

We can eliminate much run-away young engineer traffic by making it more attractive for the young Canadian engineer to stay at home; by offering him better opportunities to earn, more opportunities to advance in his profession, better status in our society and in our own Canadian industrial organization. We can also make it more attractive for him here by building up the already great reputation of the Canadian engineer, so that he will feel it unnecessary to move to the south to be found among his peers.

Enhancing further the reputation of Canadian engineering is uniquely an operation that your Institute and its members can undertake; I am sure, with success.

Canadian engineering and technology already rest on a secure foundation, established by a long series of great men, some of whom made their reputation, and their fortunes, here, and some of whom moved away.

Canadian Pioneers

It was the Canadian-born, Queen's University educated Charles Fortesque who first developed the mathematical basis for dealing with polyphase circuit problems. It was Canadian-born Joseph Hobson who designed and built the St. Clair Tunnel at Sarnia, largest sub-aqueous tunnel in the world at the time; and who also built the Victoria Bridge at Montreal and the Niagara Bridge at Buffalo. It was the Canadian engineer-scientist William Logan who helped develop the basic theory of the origin of coal, and first called attention to the geological and mineralogical importance of the Canadian Shield.

Canadian engineers spanned the continent with railroads at a time when it was thought next to impossible to do so. They developed the mines and the hydro-electric systems of the country against almost insurmountable obstacles. They have become, although many of them unknown and unsung, in a very real sense the embodiment of that legendary figure Paul Bunyon.

Big as he is, strong as he is, and tough as he is, this Paul Bunyon has a problem; the more he does, the more there is to do. But this, according to the historian, Toynbee, is the right kind of problem to have. Real progress occurs, he says, when the response to a particular challenge is not only successful in itself but provokes a further challenge, which again meets with a succesful response and so on, *ad infinitum*.

It is clear that individually and collectively those in the engineering profession have been abundantly successful in meeting past challenges and are coping with present challenges, and there is no doubt in my mind that they will seize the opportunity to respond somehow but successfully to the challenges that face us today.

Engineers are Guilty

To get back to the subject of our talk, I believe it is quite clear that engineers have, because of their success, been guilty in large part of our present dilemma. But you as individuals, and as the Engineering Institute of Canada, can do a great deal toward solving it.

In considering how this is to be done, I think it will be necessary for every engineer to look at the problem individually, as well as for engineers as a group. Soul-searching and self-challenge will be necessary. Unpalatable truths will have to be faced.

For example, is it possible that engineers have been a bit too small, too petty, in their professional approach to their work? Is there a holdover from the days when engineers literally did everything? Are individual engineers persisting in undertaking tasks that are beneath professional levels, and too often resisting progress by making it difficult to introduce technicians to aid them?

Are some engineers, possibly through a vague feeling of insecurity, insisting on carrying on too much of the slide rule and meter reading phases of their work that could just as well, or better, be turned over to men with lesser training?

I know of a number of instances where this is true. Perhaps you may know of others. Possibly some of the engineers in this room are guilty of these shortcomings.

As engineers, let us all take a new look at ourselves, our daily work, our work habits, and our attitudes. The road to true professionalism involves giving up, as well as gaining. The medical profession would never have attained its present stature if doctors had insisted on being nurses as well as physicians, or if surgeons had also continued to serve as barbers, as they once did.

It is up to the engineer himself to establish his true professional status. I believe by establishing his true professional status he will have gone a long way toward a solution of the total problem. It is the necessary road to his own salvation, as well as that of industry and the economy as a whole.

Training and Orientation of the Graduate Engineer on the Job

A panel discussion held as Session 3 of the joint Conference of the American Society of Mechanical Engineers and the Engineering Institute of Canada, University of Western Ontario, October 1956

Cornelius Wandmacher

Head, Dept. of Civil Engineering, University of Cincinnati.
Moderator of the Session

To encourage the continuing professional growth of young engineers after graduation from college, the Enginners' Council for Professional Development in recent years has promoted a plan known as the "First Five Years" program.

This is a six-point program the outline of which is based on two cardinal principles:

(a) Industry and the engineering profession must provide the young engineer with a "favourable climate" in which to grow;

(b) The young engineer must be brought to realize that the final responsibility for professional advancement rests with him, the individual.

Point No. 1 in the "First Five Years" program is directed to the matter of "Orientation and training of the graduate engineer on the job." Since both EIC and ASME are participating societies of ECPD it is therefore quite appropriate that the following papers direct attention to this program and especially to this point.

Most organizations with which young engineers now take employment offer some type of orientation and training program. Some companies merely give lip service to orientation and training; others merely organize a "merry-go-round." But the majority of firms are constantly endeavouring to evaluate and improve training methods, to determine whether present programs represent the best use of time. Do graduates of the training programs make good use of what they have learned and would they have learned as much in other ways, or on their own? That is the question which is being constantly asked.

Some views on these points are offered in the following four papers, two of which are presented by management representatives responsible for the administration of training programs and two of which are presented by relatively recent graduates of well-organized training programs.

Summary

A summary of the highlights of the four papers in this panel group and related ECPD literature should certainly include the following thoughts and ideas expressed in one or more instances:

(1) The essential need of industry is a loyal, efficient, and aggressive working organization.

(2) Training is a way of operating with new people in the total work situation.

(3) Making the trainee a part of a working team is an essential part of a realistic training program.

(4) To work, not merely to observe, should be the key to any training assignment.

(5) Put responsibility into trainee jobs — make the trainee carry a burden and learn to produce.

(6) Opportunity to contribute at the earliest possible moment to the everyday productive effort of the company is the basic desire of every trainee.

(7) Selected job experiences are the foundation stones of any training program.

8) Flexibility in training assignments is necessary to serve the best interests of the individual and give him the training he really needs.

(9) Follow-up on training must go on for a period of several years. Carry-over should be provided for and checked.

(10) The development of a professional consciousness and attitude should be the paramount goal of any training program for young engineers.

L. L. Case

Chicago Blower Corporation, Detroit, Mich.

It would seem that industry, in general, agrees that the young engineer, who is freshly graduated from an accredited engineering college, has a broad theoretical knowledge about many different fields. Conversely, he does not have enough knowledge in any particular field or the practical experience in that field to immediately become a productive part of industry — hence our topic "Training and orientation of the graduate engineer on the job."

I will discuss this topic from the viewpoint of the young engineer who has quite recently completed one of the programs, somewhat similar to those discussed by other members of this panel. My comments are personal observations and do not necessarily reflect the thinking of the company's program being discussed.

The program to which I refer is the Test Engineering Program of the General Electric Company, in Schenectady, N.Y.

Initial Assignment

On reporting for work, the new test engineer had an interview with the test director and was told of his initial assignment, for which the test engineer had earlier made known his preferences from some 98 different assignments. These tests were available at Schenectady as well as at various other plants throughout the United States, and included steam turbines, induction motors, gas turbines, magnetic control, electronic control, fire control equipment, air-conditioning and refrigeration, and many others.

During the third session. From left: Prof. Cornelius Wandmacher, the moderator; M. J. McAuliffe; and John Gammell. Not shown are L. L. Case and C. A. Peachey.

Each assignment was for a duration of thirteen weeks. Since the tests varied in their scope, the exact method of conducting each test varied considerably, but the general pattern of those in which I participated was about like this:

The first week, the test engineer was given a chance to acquaint himself with the facilities for production and testing of the product involved.

The test supervisor (himself a graduate of the test program), instructed us on the construction and operation of the product. We then studied the product thoroughly with particular emphasis on the step by step analysis of the manufacture and assembly. The test engineer also had an opportunity to learn, at least generally, some of the problems of research, development, design, scheduling and production.

After the first week, we were assigned to a "test" group, consisting of three test engineers: the leader, who had been in this group for eight weeks previously; the assistant leader, who had been in the group for the four preceding weeks; and the novice. This group worked as a team doing production testing, all under the direction of the test supervisor.

After four weeks, the novice became the assistant-leader, the former assistant-leader became leader, and the former group leader, who had then completed his "test", moved on to a new test assignment. By this progression, each engineer performed all types of work, had an opportunity to understand thoroughly the test procedures and operating characteristics of the product, and to acquaint himself with the operations of the department; he had performed productive work for the Company, and had the opportunity to show his individuality and ability for leadership.

At the end of each test, the engineer had to submit a written report to the test director, covering his activities during the test assignment and outlining recommendations for changes in the test as well as his feelings about permanent assignment to that department. At the same time, the test supervisor reported to the test director about the test engineer, including all phases of the engineer's development such as technical, creative, and leadership ability, sociability, and many others. These two reports were reviewed during a personal interview with the test director, after which the engineer's next test assignment was made.

The length of the test program varied from one to two years, which included from four to eight different tests. By this time, the engineer had become familiar with the field in which he was interested, and the Company had had ample opportunity to learn the man's abilities and his limitations, thereby enabling the test director to place him in a position compatible with the best interests of both. The engineer could "go off" test at the conclusion of any test if he so desired, but it was recommended that he complete the test assignment in his chosen department before he actually joined that department.

To me, one of the most important things about this program was that the "fresh" engineer had an opportunity to work with the finished machine or product. It was no longer a mental picture absorbed from a book, and the theoretical limitations became very real. Such experiences are not soon forgotten. Furthermore, the wide diversification of test activities was an education in itself and provided a broad practical background of great value regardless of the engineer's final position.

Another important aspect of this type of training was that it taught the young engineer the value of accuracy and thoroughness, particularly relative to guarantees. A guarantee is basically a promise to pay (either material or services) if promised performance is not met. Such promises usually involve a considerable number of his company's dollars, so guarantees and warranties will usually influence an engineer's thinking. Therefore, inducing an early respect for this thinking is quite inexpensive insurance.

The value of such close association with both the supervisors of the various departments, as well as with so many other young engineers, cannot be over-estimated. The opportunity to act as test leader gives each engineer a taste of supervisory work and also of responsibility, both of which are very important.

In addition to the actual test assignments, several advanced technical courses were available to the test engineer, which emphasized the practical aspect of engineering and kept him thinking about self-improvement.

Additional Areas of Training

There you have an outline of a very well thought-out and well-organized test program, which was and is doing an excellent job of orientating and training young engineers for industry. However, I would like to present three additional areas of the young engineer's training, which cannot be completely developed by the engineer himself, nor can they be completely covered by a training program, yet are vital to the engineer in his profession.

(1) *The Language of Engineering* —That is, of drafting and blueprint reading. Every engineer should be conversant with this method of presenting ideas. I would suggest that a minimum of six months of this work is a necessity for every electrical, mechanical, civil, and architectural engineer. Verbal orders cannot be tolerated in any business, and many times the illustration of ideas in blue print form is the fastest and most accurate method of projecting one's thoughts.

(2) *Good Verbal Expression* — This is another very important attribute of a good engineer. The ability to express one's thoughts and "sell" ideas is just as important as thinking those ideas. Many engineers are poor public speakers and yet, to assume supervisory or management duties, an engineer must possess this ability. The one fast and sure way to develop this ability is through active selling, which means becoming a "salesman" for a time, preferably six months to a year. Selling is an art in itself, although it is not classed as a profession. Similar problems are encountered whether trying to persuade a customer to purchase your product over several others, or trying to persuade your supervisor or the board of directors that your idea should be followed rather than some other plan of action.

(3) *Administrative Ability* — This is probably one of the most elusive traits to develop, and can only be improved by actual supervisory work, which is not always possible in the first few years of employment. Therefore, the engineer must find other ways to develop this ability. One of the most effective is through social, civic, and technical groups outside business associations. This type of participation not only helps the engineer himself, but also his profession and his company. These activities should be encouraged and recognized by the employer.

Finally, a good engineering education might be called the "tool box" of the engineering profession; industry can provide the facilities and capital through good training programs, but the quality of the finished product, "the engineer for industry," is greatly dependent upon the raw material, which is the ability and efforts of the young engineer himself.

John Gammell

Director of Graduate Training,
Allis-Chalmers Manufacturing Company,
Milwaukee 1, Wis.

Many students when they come to us arrive in a new world. The young graduate engineer has, up to the time he comes into our companies, been at the centre of activities involving him and indeed, the reason for those activities. For instance, he has been the centre of his family's attention and the reason for its existence. He has been the centre of attention of schools for 16 years and the reason for their existence. For the first time in his life he now comes out of the relatively orderly predictable atmosphere of schools to the unpredictable and sometimes disorderly atmosphere of industry. When he starts to college he knows what courses he is going to take, and when he walks into a math class, he knows he is going to study mathematics, nothing else. If he gets all the problems right and he gets them in on time, he gets an "A". Contrast all this with industry.

In the first place, he is on the outside of the circle fighting his way in to a position of importance. The men who will train him have primary interests in quite other directions than towards his training. Their raises and their advancements in the industry depend on how well they manufacture something; how well they design it; how many they can sell, and so on, and not on the immediate success of their training activities with an employee. In the long run, of course, this training activity may be more important to their career than their present-day job; but only in the long run. They will, therefore, neglect the student and the training any time they interfere with the proper attention to an important customer or an important conference with the top brass or a vital piece of test work which has come to a head, and so on. These people are all very much interested in the student but not as directly as were his family and professors.

The realization of this for the student and the necessity for his learning how to work under these conditions is the business of industrial training. We must somehow teach the young engineer how to establish his own curriculum; how to determine the time to be allowed for study and what he is going to study; what meetings available to him he is going to attend; what magazines he is going to read. He has to learn how to ask questions without irritating a busy man. He has to learn how to be interested and show it or he will be regarded as lacking in enthusiasm. He has to learn to do his job well and still keep this enthusiasm when he finds some one else getting a promotion because they also did their job well and perhaps were older, more experienced, or simply liked better by the boss.

The young student has to learn that to carry on a successful development is not always a matter of technical competence, but is frequently a matter of selling the officials of the company on granting money, time, space, assistance, and equipment for doing the job in competition with many other demands for the same services. My own company sponsors a special sales training course of 26 half-day per week sessions in which the student is given assignments to talk about our products, their engineering, their production, their application. We feel that to be able to talk easily and effectively about the products with which he is concerned is a highly valuable asset to the young engineer.

The young trainee has to learn that keeping a department in the black may depend as much on an emotional approach to a couple of key employees as a purely factual approach to the scientific and engineering problems of the department. He will find that the selection and discrimination which he exerts in determining difficulties in industrial activities has as much to do with his progress as does his actual knowledge of the business.

He will learn that, because of lack of time to consider all the factors objectively, he must frequently make decisions based on intuitive faith in the judgment and information given him by his associates. He must be quick to change his course when he finds he has made a mistake.

Against this backdrop of requirements and many others, the industrial trainer must plan his approach to the education of the young engineer. A common method is first to have a brief period of orientation in which the student learns something about the policies and business of the company for which he is going to work. This is followed by an on-the-job training period in which he rotates to various departments. In these he serves as a helper to more experienced engineers. He does some work and he does some study during this period, and most of all he learns how to work under the varying conditions of industry. In larger companies he also uses this period to find the type of work he wants — research, development, production, sales, application, service, maintenance, etc. After finding his field he has to sell himself into it.

In addition to on-the-job training, there are a series of survey type courses where men skilled in the various activities of the company talk to him about what they do and how they do it. There is very little rigorous education in all this, as most companies leave this type of education and the theoretical aspects of engineering to the colleges, to night schools, and special arrangements. More and more, industry is encouraging its young men to continue their academical work through going to night school and sometimes through special leaves of absence to pursue particular courses. A few larger concerns have special theoretical courses designed for their problems and for developing the more academically gifted student.

A new activity is beginning to enter industrial training operations for the undergraduate engineer. It is realized that a large percentage of them will sooner or later have responsibilities that are primarily administrative. For their success, these activities will depend largely upon the man's ability to lead and motivate others. Because of this, management seminar type courses are being carried on, or at least thought about, to an increasing degree. The top brass is taking more real interest in the young men and more arrangements are being made for them to have some contact with the beginning engineer in order that these students may have a better feel of the kind of work many of them will too soon have to undertake.

Whether or not an engineer's talent can be used more effectively when partially directed toward the managing of others, or whether it should be totally used in a purely engineering field is a subject for debate. I would point out, however, that if the engineer does not manage, who will? Can a non-engineering graduate direct engineering activities as efficiently as an engineering graduate? And aren't the most challenging problems of business becoming engineering problems?

C. A. Peachey

General Manager,
Communications Equipment Division,
Northern Electric Company Limited

There are two ways of tackling this subject. The first would be to limit the discussion to the philosophy behind the necessity for training of the graduate engineer after he arrives on the job. This method would involve evaluation and appraisal of general principles. The other method, and the one which I propose to follow, is to discuss the subject as it applies to my own particular industry and company. It is reasonably obvious that this approach would differ vastly from industry to industry and, for that matter, does differ in various areas of any one particular company. On the other hand, there seems to be a general pattern.

My company is the Northern Electric, which has about 15,000 employees. The engineering staff, excluding those who have progressed to administrative positions, is about 450.

Our engineering effort is spread over a number of fields, such as product design, communication systems engineering, design and development of manufacturing facilities, and manufacturing methods engineering for improvement and cost reduction.

Now, as has been said earlier, training needs will vary even within one company so I will limit my remarks to the manufacturing plant at Montreal which manufactures telecommunication equipment. In this plant there are about 7,500 people, including about 300 engineers, science graduates and some "up from the shop" engineers. I will leave design engineers out of my discussion as they are a particular group who must be fundamentally development-minded and with a strong preference for creative work. The majority of our engineers in this plant do not work in that area but are employed in the design and development of manufacturing facilities and manufacturing methods.

With this group in mind, I can say that when an engineer arrives on the job following graduation, he has sufficient basic technical knowledge. I am one of those who strongly favour a basic undergraduate course. The further training and education which he requires is spread out into three fields.

(1) Orientation

This is immediately required for most graduates and is intended to develop the man into a useful and enthusiastic member of the industrial society in which he finds himself. This implies that he must develop in the language and "know how" of a particular industry, and must develop an awareness of how he can contribute in a productive way to the objectives of the whole organization.

For a time after the War, many graduates coming into industry were mature as a result of their wartime experiences, and today those graduates who have been employed in industry during the summer months have often become oriented so that they can proceed quickly to fit into their new assignment. A number of graduates, however, have not been exposed to an industrial atmosphere and, as a result of their university training, they tend to react technically to situations and think in the abstract to a point where they lose communication with some of their fellow employees.

The first part of the training which the engineer receives is an explanation of the organization, its purposes and the possibilities he will have to make a creative contribution to the organization. When he senses these possibilities, he will develop an interest in his work, and should be motivated to further self-discipline in the direction of hard work. He should come to affiliate himself with the organization and finally see his own job as meaningful and important.

This orientation training specifically consists of a combined shop course of about four weeks' duration, interspersed with a series of talks, followed by discussion periods. During his tour of the shops, the engineer is under the guidance of a "sponsor" engineer, and he is asked to turn in a report on his shop study. He gets a quick overall tour of the entire shop, and then makes a more detailed study of one particular product shop. He is asked to turn in another report on a more general topic at the end of the four week period. This topic may be selected from one of a number, such as material handling, accident prevention, inspection methods, etc.

The series of about 20 talks which are interspersed into the engineer's study of the shop are given by various members of different organizations, from the works manager down. They include talks on the company's history, organization, stock holdings, and its place in the telephone industry, and help both the engineer and management in that they afford some opportunity for higher levels of management to meet some of the engineers. There are always question periods after these talks.

(2) Technical

We find that the men are anxious to get to work and, after four weeks, our new engineer becomes a working engineer. Further technical studies are then required on his own on the specific problem which is assigned to him. He might be working with vacuum tubes, punches and dies, chemical processes such as electrical plating or plastic moulding, and is expected to delve into the technical aspects of the particular problem and apply the basic principles which he has learned in college, so as to become proficient technically in his immediate specialty. The detailed technical studies are left to the man himself, as he is already prepared by training to advance quickly in this regard.

During this period, all new engineers attend several other training courses.

(a) Work Simplification and Work Measurement (100 hours) — Toward the end of this course, a class is split into a number of small groups, each of which studies a particular job in the shop and works as a team analyzing the operations in detail; later the groups meet as a class again and discuss, evaluate, and compare the various proposals made by each team.

The work simplification and work measurement courses are specific tools of scientific management, but the training has also the second purpose of developing creative thinking on the part of the engineer in his daily work. This attitude is most important, as the engineer's main contribution is from his ideas. He is more highly paid, must produce more. Technical assistants may perform a lot of the leg-work and measurements, but the ideas — and the selling of them — come mostly from the engineering group.

(b) Statistical Quality Control — This is another basic tool of scientific management. This course teaches a few basic principles but mainly application techniques.

In addition, depending on the engineer's area of work, he is given a course on: (i) production machines, or (ii) wired equipment test set design, or (iii) theory and operation of communication facilities.

(3) Human Relations

This third phase of training is interspersed with phase (2) and is an attempt to give the engineer some self insight and develop his skills and ability in handling difficult situations with people and methods of motivating people. This training involves case studies along the lines of the Harvard case study approach. It is this part of the program which is usually commented on by the engineer as being the most valuable. In this program we use films and slides, as well as case studies, and an experienced moderator guides the discussions. By and large, the engineer is encouraged to work out the problems in the group. An engineer would not develop the right attitude toward feeling-people-situations by just being told that he must; he has to discover these things himself and what we think we are doing is to speed up the process. I see little gain in a university teaching this in the undergraduate period. It can be readily handled by industry.

These three basic training courses are applied to our engineers with more or less success depending on the individual. We are constantly attempting to improve the program and it changes from year to year. About 20 per cent of the first year is spent in conferences and classes. We encourage engineers to take courses at the local universities and allow them time for writing theses for higher degrees, and assist in other ways, such as use of typists, etc.

Engineers are encouraged to join professional societies, and those who show special interest usually find themselves on committees in these societies. Some of our engineers gravitate to the Junior Board of Trade and, to encourage this, we pay for a few memberships in that organization. This gets an engineer away from engineering and into community affairs, and tends to broaden his outlook.

After a few years, the engineer may expect to find himself supervisor of at least a few other engineers and requires at that time some study and knowledge of administration techniques. He begins to realize his tools are speaking, writing, listening and reading, and of course, thinking. Some engineers take courses in rapid reading and join public speaking classes which are sponsored by the company. Some of them study general semantics and learn how to think more clearly and to appreciate the importance and significance of communication and the implications behind many things which are spoken, both by themselves and others.

After an engineer becomes what we call "department chief level", i.e., if he has not become a specialist, we feed him through a more advanced course on business administration. A professor from the local university gives lectures with discussion periods; these lectures run on for about 20 weeks. This training usually develops an interest in the subject, and the man can follow up the course by reading to find out more about the subject.

In general, our training program is not too unlike the six-point program developed by the Engineering Council for Professional Development, in the United States. There are some differences, of course. We do not do much in the way of integrating a man into the community, as Montreal is such a large area. Newcomers to the city are given guidance by resident engineers, and usually the wife of one of the engineers takes the wife of the newcomer under her wing and shows her housing developments, and so on.

Perhaps some people will feel, as I do myself at times, that by too extensive training sponsored by the company we are taking the initiative from the engineer himself. This criticism is partly valid and is one of the disadvantages of the training program. I feel, however, that the exceptional man will provide himself with additional training over and above what we give him and, therefore, our program should raise the average all around. All in all, an engineer in our company may expect that his education will be a continuing one throughout his entire career.

M. J. McAuliffe
Assistant to the General Manager, Industrial Products Group, Canadian Westinghouse Company, Ltd.

My remarks are directed to one specific phase of training, the phase that I believe to be the most important, and yet is the most neglected. I refer to the training required to take a graduate engineer and produce a professional engineer — the development of a proper mental attitude on the part of the industrial engineer and industry.

I am not minimizing or overlooking the need for planned orientation and technical training, but most companies provide the training now, and other members of this panel discuss this necessary phase of training in more detail.

I wish to discuss the professional man in industry from several points of view; particularly his recent arrival in increasing numbers on the industrial scene; his place in the evolving organizational scheme of industry; and the much-discussed shortage of professional men just now —particularly the alleged shortage of engineers and the effect that training can have on these aspects.

These are problems with which my own company, as well as those represented by many of you, have been grappling for some time. I hope that what I shall have to say will prove helpful — or at least will present starting points for new thinking on these matters.

Until quite recent years, in thinking of industrial organization, it sufficed most people to consider only two classes, or groups, in the structure. On one side was "management", which often in the early days included the owners as well as those who provided planning, direction and the other attributes of managerial skill. On the other side were the "employees" — those who did the manual work, tended the machines, and carried out the accompanying clerical tasks.

There seemed to be no place in this conceptual scheme for the professional man: for the engineer, the accountant, the lawyer, and the like. Nevertheless they were necessary to the effective functioning of industrial organizations, and since they were necessary, they increased in number.

Most managers, I suspect, thought of them generally as employees — a variety of clerical worker. And most professional people in industry thought of themselves in the same terms. The professional man's place in industry seemed undefined and insecure. Many professional men sought to better their positions by forsaking the professions which they had chosen as their life work, by becoming members of "management", as a means of obtaining recognizable status in the organization.

But then after the beginning of the century, and at an accelerated pace after the first and second World Wars, the numbers of professional men in industry rapidly increased. Whole industries, such as my own, and the chemical, the automotive, and many others, came into being, industries whose very existence depended on technological ideas and developments.

Professional Group

Today, when much of the effectiveness and productivity of an industry is the result of the increasing numbers of professional people in the structure, we can no longer consider the professional man as just a special type of white collar employee, or the representative of a minority group in industry. He does not carry on in some sort of hazy limbo between the managerial group and the employee group. Professional men are a group themselves, a major one, a third force in industry. I like to think of them as representing the "third estate" in modern industrial society.

Because of the rate with which this "third estate" is growing, and because of the utter dependence of modern business and industry upon trained professional men, the professional employee today represents one of the world's scarcest and most valuable commodities. No business could be considered well managed which did not realize the importance of the professional people within its structure, or which failed to make proper provision for their effective utilization, integration, and development.

In general, I think, managements have been quicker to perceive the place and importance of professional employees in the industrial structure than have the professionals themselves. One of the ills of industry just now is the great turnover of engineers and other professional people: their leaving one company to go to another, and more especially the drive of some to forsake the professional fields for which they have been carefully trained, to become members of management.

It is as though a general restlessness and feeling of insecurity still permeates the thinking of professional people in industry, causing them to seek other places and other work; and perhaps to neglect the opportunities for professional, personal and economic satisfaction and advancement that are readily available to them where they are.

This is so, I think, because so few professional people as yet realize that they make up a large and growing army of the "third estate" in industry; that they do have position and opportunity at least equal with those of the other groups in the industrial structure; that a man does not have to give up his profession and become a manager to be important, successful and happy in the industrial scene.

Let us consider for a moment what peculiar qualities distinguish the "third estate", what special advantages, opportunities, rewards, and obligations go with membership in the professional estate in industry.

It has frequently been said that one principal difference between the position of a manager and that of a professional employee lies in the fact that the manager works with and through people, whereas the professional is an individualist who does not work with people. This, of course, is quite untrue.

In most cases, the professional man in industry must and does work with others; with other professional people, with non-professionals and with managers — in short with the whole range of people in his environment. He can hardly be successful unless he does so. For like the manager, the professional man has both individual and teamwork responsibilities.

The real difference, it seems to me, lies in this: the manager is responsible for the results of his department, and thus is accountable principally for the work of others. But the professional man is essentially responsible only for his own work, whether he works alone or as part of a group. He is thus in a creative position with regard to his work; he can take a special pride in it, because it is his own. As we all know, it is difficult — often impossible — for a manager to point to any particular piece of work that he specifically has done. To others, nearly always, must go the recognition and the credit. But this is not so in the case of the engineer or other professionals. Their work is the result of their own personal creation, insight and skill. Even when working with a group, they can usually take justifiable pride, and obtain deserved recognition, for what they have been able to accomplish.

The position of the professional in industry also differs considerably from that of the non-professional, non-managerial employee. The non-professional employee's task usually is to carry out plans and achieve objectives set by others. But the professional is responsible for setting his own goals, and developing the means to achieve them. In large part, the professional's job is to teach others how to perform tasks or produce goods which, without professional guidance, could never have existed.

Thus the professional man in industry is usually in an unparalled position to advance both himself and the interests of his company but in few companies today can he feel that his status equals his importance to the organization's success. His monetary rewards in most companies are high. But to realize his full potentialities he should also have a special kind of status; one that will set him apart from both of the other "estates".

Responsibilities

He must, of course, be willing to pay a price for this, as industry must also. For only by mutual acceptance of responsibilities and adjustment of attitudes can so major a change come about in the industrial scheme.

Today, however, we find a large percentage of engineers being misemployed; engineers doing non-engineering work; and many instances where a given engineer could accomplish considerably more in his own technical sphere if he had suitable trained assistance in the form of technicians, whose training and abilities need not be nearly so extensive as his.

In speaking of misemployment of engineers, I am not, of course, referring to those numerous instances where engineers are satisfactorily filling supervisory or management positions. It must be realized that graduates of so-called university professional courses will always continue to fill positions in many fields — something that should be encouraged, for it is the primary job of a university to teach people to think, and not merely train them for technical specialties if they have other abilities or ambitions.

In our own company, where we have been studying this problem extensively, we have found engineers doing time study, serving as order clerks in the pricing department, engaged in minor redesign of equipment that could just as well be done by men of lesser training, converting drawings from the metric system, and revising or changing stock order numbers on Kardex cards.

Nor have we been alone in commiting such sins. In a recent article in *Machine Design* on "How to Relieve the Manpower Shortage" Chester Linsky of the Pennsylvania State University quotes recent surveys that show engineers being used in at least 75 non-engineering jobs in a variety of industries. These non-engineering jobs range all the way from draughtsmen to checker, estimator, plant maintenance man, core room supervisor, traffic analyst, technical writer, and tool room foreman.

I think we will find, when steps are taken to eliminate misemployment of engineers, give them suitable status in the organization, and supply them with adequate help, a large part of the shortage will disappear.

The benefits to industry should include lower engineering costs per unit, increased engineering productivity, greater flexibility in the application of technology to products and processes, and lower turnovers of engineers and other professionals. As management begins to realize fully the importance of the professional man and the significance of his new status in the industrial organization, his misemployment will become unthinkable, and therefore less and less possible.

For the professional man, the gains will also be many. He will have a new sense of security and belonging, a new urge to create and produce, a finer sense of his own place and importance in the scheme of things. We will not then have to worry about inducing more bright, ambitious young men to enter technical or professional fields; they will begin to look upon these fields as the areas of choice for an industrial career — as indeed they are in our surging technological culture and economy.

These gains, however, will not come about without cost or effort.

In the first place, it requires determination and persistence of a high order, on the part of management, to discover and change all the instances of misemployment of professional people in large organizations. In some cases skills that have long been disused have been lost, and retraining may be necessary. In others, there are resistances to change, not only by the surrounding units of the organization, but occasionally even by the professional men themselves —though I believe the management that succeeds in establishing high respect and high estate for professional people will find that such resistances will rapidly disappear.

Finally, much has yet to be learned about applying the engineer-plus-technician team technique in industrial situations.

Rich Rewards

I am convinced that rich rewards will be gained by persistent efforts in this direction, not only for the industries that succeed, and for the professionals in those industries, but also for their customers and for the nation as a whole. As our country develops, it seems certain that there will always be more need for technical and professional skills than can readily be supplied — and every improvement in the utilization of these talents will be a gain for all.

This training must be designed to change the mental outlook of both the individual engineer and the employer. It will be a difficult and time-consuming process, requiring the support of the top man in each organization, the Universities, technical and professional societies. It is a task that none of us can afford to neglect.

A committee headed by Dr. A. C. Monteith, vice-president of the Westinghouse Electric Corporation, in their report "The First Five Years of Professional Development", stressed the need for this development during the five years following graduation. It is during this period that the individual usually decides whether he is going to be more interested in the technical or administrative side of a business enterprise. It is during this same period that the foundation is laid upon which his business career is to be eventually built. The success of our Company tomorrow will depend to a large extent upon the quality and excellence of the professional work force we build today.

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

OXYGEN CUTTING TITANIUM AND TITANIUM ALLOYS

G. Coates, *The Engineer*, v. 203, no. 5270

In comparison with mild steel, titanium is characterized by a lower density, lower thermal conductivity, but a higher melting point and a much greater affinity for oxygen. The heat formed by combustion with oxygen during flame cutting is greatly in excess of the losses by conduction through the sides of the cut, and consequently titanium cuts with great rapidity. The ignition temperature is fairly high, about 1100 deg. C., but once having started the cut it can be made to progress at least five times faster than for steel of equivalent thickness. Successful cuts have been made in titanium sheet or plate from 1/16 to 3 in. thick and in a 9 in. dia. Ti 150 cylindrical billet. Sheets can be cut in stacks without tight clamping, however the mass of kerf metal removed will increase with the depth of the stack.

In commercial alloys there is the possibility of transformation hardening at the flame-cut edge owing to the rapid quench effect following flame cutting. Titanium has a very high affinity for oxygen, nitrogen, and hydrogen, and since the principle of oxy-cutting depends upon the raising of the surface to the melting point in a highly oxidizing stream, it is impossible to prevent surface oxidation and some micro-cracking. Therefore additional surface treatment by mechanical methods may be required. Examination of the surface hardness at the cut for various thicknesses of pure titanium and of alloy plates showed that the depth of hardening (0.05 in.) is virtually independent of thickness. In general the micro-cracks are at right angles to the drag lines and extend to a depth about equal to that which would need to be removed by subsequent machining to clear away the hardened zone. The affinity of titanium for oxygen is so great it is likely that alloy constituents up to a total of 10 per cent would not greatly affect the rate of cutting. A comparison of total costs including labour and salvage recovery of sawing swarf shows slight differences between sawing and flame cutting with an advantage to the latter for sections of intermediate thickness, and in every case a considerable saving in time. It is concluded that in certain circumstances oxy-cutting might have an economic future. Applications for which it can be considered are: (1) cropping of billets and trimming of thick sections in the early stages of production; (2) preparation of sections for welding; and (3) scrap cutting.

A 9 in. section which would take hours to saw may be flame cut in a few minutes, and although at present for very thick sections the cost bears unfavourable comparison to sawing this is due chiefly to the cost of the metal and the importance attached to the reclamation of sawing swarf. As the metal production rates rise in the future the metal costs can be expected to decrease. In preparation of sections for welding the major problem is the contamination of the surface layer by gaseous constituents which would cause the weld metal to be similarly contaminated even though welding is conducted in an inert atmosphere. The most serious contamination is in the surface slag and this can easily be removed by light grinding. The determination of the exact amount of material to be removed for this purpose is considered a worthwhile subject for further investigations.

EDDYSTONE PLANT EMPLOYS SUPERCRITICAL-PRESSURE CYCLE

Mechanical Engineering, v. 79, no. 2

The Philadelphia Electric Company plans to construct a steam-electric plant of 325,000 kw. capacity operating at a super-critical pressure of 5000 p.s.i.g. with a 1200 deg. F. turbine throttle temperature and two reheat stages. This marks a new high in the development of the steam plant cycle. It is being planned jointly by the Philadelphia Electric Company, Combustion Engineering Inc., and Westinghouse Electric Corporation. Among the innovations being tried are, using the lowest pressure bleed steam to heat the combustion air, and using a low-level economizer to heat the condensate thus lowering the stack temperature to about 200 deg. F. Nine stages of feed heating provide 574 deg. F. water for the boiler. The heat rate under nominal loading and with 1 in. Hg. abs. back pressure is calculated to be 8016 B.t.u./net kw.hr. The normal fuel is to be bituminous coal.

Because there is no drum to provide a steam disengagement surface, there is no water level to use for feed-water control in the once-through boiler. The temperature of the fluid at the outlet of the transition section (where water changes to steam without flashing) will be slightly superheated at 900 deg. F. and this is used to proportion water flow to firing rate. In starting a once-through boiler water is pumped through the system at the rate of about one-third maximum flow. This is the minimum flow considered adequate for ensuring sufficient circulation through all tubes. The turbine is not in operation and the flow takes place through turbine by-pass valves into a by-pass separator. After this flow is established the fire is lit. As the temperature increases, some of the water flashes in the separator and is conveyed through the reheaters to the condenser by way of a condenser injection cooler. Thus the reheaters are prevented from overheating. The hot water which does not flash drains from the separator to the condenser. When a suitable temperature is reached there is no liquid and only steam leaves the separator. The stop valves are opened and the turbine started. As the turbine comes up in load the pressures at various points in the turbine are increased and this automatically closes the turbine by-pass valves.

The boiler unit delivers steam at a rate of 2 million lb./hr. and has two identical furnaces of the dry-bottom type, each fired with tangential burners located in the four corners. Since there are two reheaters one can be controlled independently by burner tilt, thus avoiding the necessity for spray desuperheating.

The superpressure turbine is being designed and built by Westinghouse Electric Corp. for a rating of 325,000 kw. The regenerative cycle is employed with eight extraction stages from the turbine and an interposed stack gas heat exchanger. The turbine is the cross-compound type and consists of several higher pressure elements operating at 3600 r.p.m. and an 1800 r.p.m. double-flow low-pressure element.

A condenser of 150,000 sq. ft. is designed to condense 1,288,000 lb. of steam per hour and maintain a pressure of 1 in. Hg. abs. with 200,000 g.p.m. of 58 deg. F. river water passing through the tubes. The boiler feed pumps, in duplicate, are arranged in a series of three: low, intermediate, and high pressure. Each develops more than 2000 p.s.i. at full load. The first two are driven at constant speed by two-pole induction motors of 4000 h.p. and 4500 h.p. respectively. A steam turbine of variable speed drives the high pressure pump. This turbine is rated 5000 h.p. at 5190 r.p.m. when operated with steam at 1110 p.s.i.a., 790 deg. F. at inlet and 290 p.s.i.a. at exhaust.

CERAMIC INVESTMENT SHELLS GIVE HIGH-QUALITY CASTINGS

N. J. Grant and P. Manganaro, *The Tool Engineer*, v. 35, no. 2

A method of producing ceramic shell moulds for improved precision casting has been developed recently. A ceramic powder called Glascast is applied in a slurry form as a coating on a disposable wax pattern. Three to six successive coatings are applied, each followed by a period of drying. The wax is removed by heating in a furnace at 1850 deg. F. and the ceramic shell gains a high temperature sinter band before the wax melts. This enables the shell to withstand expansion pressures created by the melted pattern. After removal of the wax the mould is brought to the casting temperature for the workpiece material and the metal is cast. Usually no support is required around the outside of the shell.

Problems of cracking and spalling of the shell during firing were encountered and were found to be caused by too rapid or too slow drying in the coating operations, or by uneven coating thicknesses. A number of different binders and coating mixes were tried. Best results were obtained using Nalcoag or ethyl silicate slips for the first two coats and a phosphate bonded Glascoat mixture for the outer coats, together with foam silica stuccoing for rapid wall build-up. These moulds were found to be capable of withstanding rapid heating or cooling without cracking.

Casting tests were carried out using a large jet engine turbine blade as the workpiece. The effect of large particle size of the ceramic material was found to produce a "pebbling" of the casting surface or occasionally a fine craze cracking. A water indicator, cobalt chloride, was added to the slurry causing it to change from pink to blue on drying. With careful drying procedures using air at low humidity and controlled temperature numerous blades were produced with nearly perfect surfaces.

Castings weighing up to five pounds have been made using casting temperatures as high as 3100 deg. F. In casting plain carbon steels the metal cools more rapidly than in the case of the usual massive investment mould. This gives a finer grain structure and less decarburization. Further investigations proposed involve determination of dimensional corrections to obtain 0.005 in. per inch tolerance on castings, the size limitations of unit castings and total casting weight, and the maximum size of ceramic shell which can be used without exterior support.

ADHESION AND FRICTION

F. P. Bowden, *Endeavour*, v. 16, no. 61

Recent experimental investigations have given some knowledge of the local changes which occur when one solid slides on another under various conditions. This information on the physics of solids has great practical importance in such diverse fields as the construction and lubrication of bearings, the polishing of materials, de-icing of aircraft, and the formulation of adhesives.

It is evident that there is a close connection between friction and adhesion. Friction is essentially the shear strength, and adjesion the tensile strength of the junctions formed at the region of contact of solid materials. For most solids, whether they are plastic, brittle, or elastic, the surface adhesion can be strong. The differences in the frictional behaviour of various solids are due mainly to the difference in their mechanical properties, since it is this which determines both the area of real contact and the shear strength of the junction. Materials which give a high coefficient of friction will potentially give a strong adhesion. Whether this adhesion is observed or not depends primarily on the effect of elastic stresses released when the load is removed. If these stresses can be avoided, or if their effects can be accommodated by the ductility of the junction points, the potential adhesion will be observed. If they cannot be eliminated the observed adhesion may be very small indeed. Lubricants which reduce the friction by diminishing the amount of metallic contact produce an even greater reduction in the adhesion.

Experimental laws which govern the friction of solids sliding on one another are simple. It is usually found that the frictional resistance is directly proportional to the load and is independent of the size of the surface in contact. A detailed examination of the contour of solid surface offers a ready explanation for these laws. Even with the best modern methods it is almost impossible to make a surface which is truly flat, and to a person of atomic size an optically or electrolytically polished surface would look like a landscape of valleys and hills differing in height by a hundred atoms or more. Most of the engineer's best surfaces have irregularities greater than this and may be thousands of atoms high.

Measurements of the electrical conductivity across metal surfaces placed together confirm that the real area of contact is indeed very small. It varies with the load, but for flat steel surfaces it may be less than one ten-thousandth of the apparent area. Such experiments also show that the real area of contact is almost independent of the size of the surface. It is very little influenced by the shape and degree of roughness of the surfaces. It depends mainly on the load which is applied and is directly proportional to the load. The general behaviour is consistent with the view that the surfaces are held apart by small irregularities. This means that, even with lightly loaded surfaces, the local pressure at these small points of contact is very high and may be sufficiently great to cause the hardest metals to flow plastically. Although the stresses will cause elastic deformation of the metal in the vicinity of the points of contact, the experiments suggest that the summits of irregularities on which the bodies are supported flow plastically and are crushed down until their cross-section is sufficient to enable them to support the applied load. There is strong evidence that the friction of metals is due, in large measure, to adhesion at these contact regions and represents the force necessary to shear these small junctions. The shearing may occur at the interface, but more frequently (because of work-hardening of the contact region), it occurs a little distance beyond it. A metal fragment is thus detached from one of the surfaces and adheres to the other. The transfer can occur from a hard metal to a soft one as well as conversely.

Metal surfaces exposed to the air are always covered by a film of oxide or adsorbed gas. This may be only a few molecules thick but it has a profound effect on the adhesion and friction. If the film is removed by heating the metals and allowing them to cool in a high vacuum the friction is increased. If sliding is attempted the area of real contact increases and the friction may reach an enormous value.

Since there is strong adhesion at the local regions of contact when two metals are placed together it would

INTERNATIONAL GEOPHYSICAL YEAR

The arrangements committee of the International Union of Geodesy and Geophysics XI Assembly in Toronto, September 3-14, pose with equipment to be used this summer by University of Toronto and Canadian Research Board expeditions in British Columbia and the Canadian Arctic to study glaciers as part of the International Geophysical Year. The IUGG is a group of international scientific organizations whose interests extend over nearly all aspects of the IGY. The various projects of IGY will be the chief topic of discussion by 1500 delegates from 50 countries at the meeting. Papers will be given on such diverse subjects as the Vanguard satellite which will probe the secrets of the earth's atmosphere to others on the basic structure of the earth itself. Professor J. T. Wilson (centre), vice-president of the IUGG and chairman of the arrangements committee, holds a gravimeter for measuring gravity on Canadian IGY investigations. In front of Prof. Wilson, J. A. Jacobs, secretary of the committee (left), and R. M. Farquhar may be seen various seismic equipment.

be expected that the force required to pull the surfaces apart in a normal direction would be comparable with the force with which the surfaces were originally pressed together, but this is not generally observed. Friction is always measured while the normal load is retained, but to study adhesion the normal load must be removed before any adhesion measurements can be made. In the course of removing the normal load, the elastic stresses in the material surrounding the junctions will be released, and there will be a slight change in the shape of the interfacial contour. The junctions themselves being highly worked will be relatively brittle and very small tensile displacements will break them. Therefore as the normal load is removed the junctions are pulled apart one by one so that practically none are left when adhesion measurements are to be made. Metals which are soft and ductile do not work-harden under the test conditions and have consequently indicated coefficients of adhesion as high as 1 (i.e., the normal force required to pull the surfaces apart is as great as the original load). Tests have been made in high vacuum of hard metals such as platinum, nickel, and silver. Friction of these naked metals is very high and normal adhesion at room temperature negligibly small. However, if the temperature of the metals is raised so that annealing can occur and then allowed to fall to room temperature, the adhesion is very strong. If an attempt is made to slide the clean metals the combined tangential and normal stresses will cause plastic flow of the contact regions, so that the area of contact, and hence the adhesion, will increase. Adhesion coefficients of well over 10 have been measured at room temperature. This adhesion of clean metals forms the basis of the process of cold welding.

A study of the frictional behaviour of some polymer thermoplastics (e.g., polystyrene, nylon, polyethylene) sliding on themselves has shown that all have coefficients of friction of the same order as the metals, except PTFE (polytetrafluoroethylene; e.g., Teflon) for which μ is phenomenally low. Close examination of the surface damage shows marked adhesion, plucking, and transfer of the plastic from one surface to the other. This is also the case when plastics slide on metals and a relatively soft plastic can produce slight wear of a much harder metal. One major difference in the frictional behaviour of plastics compared to metals is the effect of load. With metals the deformation at points of contact is truly plastic and therefore the real area of contact is directly proportional to the load.

With long-chain polymers which are visco-elastic their deformation depends on the geometry of the surfaces, the load, and the length of loading time. The coefficient of friction increases as the load is reduced and can be very marked at light loads.

With most plastics adhesion is strong and shearing takes place at a little distance from the interface so that transfer and wear occur. The low μ value for PTFE is due to the fact that adhesion is small and slip can occur at the interface. This appears to be an inherent property of the material since it retains its low friction even in high vacuum. If the surface is subjected to prolonged running at high speeds the frictional heating can damage it and cause a rise in friction.

The low μ value for graphite (0.15) has previously been attributed to its lamellar structure which allows it to shear readily. However, experiments indicated that when graphite is thoroughly outgassed by heating in a vacuum, the friction rises considerably (to 0.5) and there is great increase in wear. Small amounts of oxygen or water vapour can reduce the friction of outgassed graphite to its normal atmospheric value. Measurements of graphite sliding on itself and on metals at high temperature and in a high vacuum have indicated a decreasing μ value with increasing temperature. With such metals as copper, silver or gold this behaviour continues until the melting point is reached. However with such metals as nickel, titanium, molybdenum, and iron the friction begins to rise above 1000°C. when carbides or solid solutions begin to form with the graphite. The area of contact increases and the surface layer is a metallic carbide having a high shear strength.

Observations of the adhesions of ice to metal surfaces have shown that, if metal surfaces are really free of contaminating grease films, the adhesion of ice to all metals is greater than the strength of ice, so that any break must occur in the ice itself. The fracture of ice bears a certain resemblance to that of metals in that, under different circumstances, either brittle or ductile fracture can occur. Evidence shows that in the range of zero to -6° C. the failure is ductile. It is influenced by the rate of plastic deformation and is very dependent upon temperature. Below -6°C. the failure is by brittle fracture and the strength is no longer dependent upon temperature. A small amount of contaminant, such as a fatty acid, on the surface will reduce the adhesion to a low value and the failure will occur in the layer of the contaminant. The adhesion of ice to plastics has shown a similar behaviour except in the case of PTFE where adhesion is very small and the break occurs at the interface.

Sliding friction on ice is very low ($\mu = 0.03$) and is due to the formation of a water film. At temperatures close to 0° C. the water film is formed by pressure melting, but with appreciable speed and below zero temperatures the local surface melting is caused by frictional heating. There is evidence that in skiing it is this frictional heating and melting which is the major factor responsible for the low friction. The frictional behaviour is influenced by the contact angle which the water film makes with the surface. PTFE, because of its inherently low friction and because of its high contact angle in consequence of which it is not wetted by water, should have useful applications in skiing, sledging, and aircraft landing. Tests to determine static friction at various snow temperatures of skis coated with a conventional ski lacquer, a racing ski wax, and with PTFE showed that the friction for all these surfaces falls as the snow warms up from -10° to 0° C. Below -10° C. μ is fairly constant and all three surfaces approach a minimum value of 0.04 to 0.05 at 0° C. However at -10° C. μ values were 0.43 for the lacquer, 0.20 for the racing wax, and only 0.06 for PTFE.

UNDERGROUND WAREHOUSE EXCAVATED IN GRANITE

C. D. Zernichow and H. Moyner, *Civil Engineering*, v. 27, no. 1

Lack of sufficient level ground in Norway's capital city, Oslo, has resulted in the construction of a warehouse by excavation of series of tunnel-connected chambers in a granite cliff rising from the sea. From the shore two access tunnels 28 ft. wide by 32 ft. high were driven straight into the cliff for a distance of 525 ft. Crossing these at right angles, six parallel chambers were blasted out, each 633 ft. long, 46 ft. wide and 30 ft. high. The rock cover over the outer cross chamber is about 80 ft. thick increasing to about 250 ft. over the inner chamber. About 200,000 cu. yd. of rock were excavated and dumped into the steep fjord outside the adits to form access roads and future quays for unloading ships. The quantity of explosives used varied from 1.2 to 1.4 lb. per cu. yd. and required a total working force of 0.8 to 0.9 man-hours per cu. yd.

Precast panels and arches form the walls and ceiling of the two-storey structure in each chamber and 336 cast-in-place cylindrical columns support the cast-in-place second-floor slab. A total of 13,100 cu. yd. of concrete and over 1000 tons of reinforcing steel were needed. The units making up the walls and arched ceiling in the storage chambers were pre-fabricated. Most of this concrete was treated by the vacuum curing process, as were the cast-in columns in the first storey. It was the first time this process has been used in Norway. Only two specially built vacuum steel forms were employed for pouring the columns and the form could be removed in an hour.

Ventilation is supplied by two units, one being installed in each of the two entrance tunnels. The total cost of the warehouse was 16 million Norwegian crowns. In Norway underground warehouses are slightly more expensive to build than ordinary surface types but the cost of heating and cooling is considerably lower.

CERAMIC CUTTING TOOLS FOR MACHINING

Machinery Lloyd, v. 29, no. 2 and *American Machinist*, v. 101, no. 3

Ceramic cutting tools (i.e. cutting tool tips) are at present at a crucial stage in their development. Though they are well established for the machining of abrasive non-ferrous materials such as asbestos-plastics laminates, these tips have yet to reach their true position in metal cutting. Suppliers of suitable ceramic materials are the American companies — American Lava, Stupakoff, Adamas, Diamondite, and Sintox. As an example of the properties of such materials Sintox, which was originally introduced as an insulator for high grade spark plugs, has at least twice the strength of porcelain in tension, compression, and cross-breaking. The dielectric strength is also twice that of porcelain. The electrical resistance is little affected by temperature but its most unusual property is that the thermal conductivity is about twenty times that of porcelain (more nearly comparable with steel). It is harder than glass and as a cutting tool produces a fine surface finish with no build up, also a low coefficient of friction is achieved under all circumstances.

Experience has shown that the basic essential for obtaining good results when using all types of ceramic tool tips is to provide adequate support for the tip. While success has been met in experimental work, in production operations the major problem has been excessive vibration in the cutting tool and in the toolpost holder. It is vibration which cannot be seen but usually can be felt. Efforts are being concentrated upon developing a toolpost holder which will reduce vibration sufficiently to ensure production quality and longer tool life.

Round tips, which are mainly used for heavy duty turning and facing, can be indexed as the cutting edge wears and can finally be reversed and re-used on the reverse end. Square inserts are supplied with four cutting edges at each end. Ceramic tips are relatively cheap in initial cost and are normally considered as throw-away inserts, although they can be readily reground using a diamond wheel and a vibration-free machine. Tips are mounted in various fashions. The most common method is a slotted alloy steel tool holder with a screw clamp. Some inserts have been metallized, allowing them to be brazed to a tool shank, and a plastic resin adhesive mounting is under development.

The same inserts can be used for cuts ranging from 0.001 in. deep to 0.300 in. with a similarly wide range of speeds and feeds. Square inserts are better than triangular because the 90° corner is better able to withstand overloading than the 60° corner. A 1/16 in. nose radius on the tip was found necessary. Tool life has proved to be erratic under production conditions, but in the laboratory ceramics have proved superior to carbide on hard materials.

At present no specific make of ceramic can be selected as being the most satisfactory. All grades appear to give best results at speeds considerably higher than those used with carbide. All grades require a larger nose radius than with carbide and are most satisfactory with a 15° or greater lead angle. Problems preventing more general application of ceramics in production work are found in the design of tips and holders. Also it is probable that machine tools designed for use with conventional carbides and high speed steels do not provide sufficient speed (and/or torque) necessary for successful cutting by ceramics. Milling cutters, boring tools, drills and super-finishing tools are currently under development. Despite the present unsatisfactory tool life, the productivity and surface quality resulting from ceramic cutting is outstanding and a much greater degree of success is expected in the very near future.

The titles of the articles in the two reference works are "Ceramic Cutting Tools Offer Advantages for Machining" *(Machinery Lloyd)* and "Martin Tests Ceramic Tools".

GROUND ELECTROMAGNETIC SURVEY UNIT

A new portable electromagnetometer, known as the Ronka Ground EM unit, has been developed by Vaino Ronka, an electronics engineer with Aeromagnetic Surveys Limited, of Toronto. In the illustration, part of the equipment is seen carried by Robert Parker, who did the production engineering of the unit. The device has been used operationally and experimentally for over a year, and was publicly introduced at the Prospectors and Developers convention, in Toronto, in March 1957. The equipment consists of two horizontal electromagnetic loops, one round each of two operators. One prospector carries the receiver coil and receiver compensator console, and has earphones. His companion wears the transmitter coil and is connected to the receiver by a 200-ft. cable. The working principle is in general the same as that used in airborne magnetometer surveying equipment. It is said that up to five miles of picket line can be surveyed in a day.

LONDON AIRPORT

The June 1956 issue of *The Engineering Journal* contained an article by A. R. Macrae and C. Heyes on the engineering aspects of the construction and operation of London's international airport, now among the most efficient in the world and certainly one of the most acceptable from the traveller's point of view.

Her Majesty's Stationery Office has recently published an attractive and well-illustrated booklet (64 pp.), "London Airport", for Britain's Ministry of Transport and Civil Aviation. This explains, in non-technical terms, the origin of the airport, the passenger facilities, how the airport handles its aerial traffic, and the essential background services such as maintenance, power, and communications.

The airport caters not only for passengers, but has facilities for feeding and otherwise entertaining large numbers of the general public; there were over 600,000 casual visitors to the airport in six months in 1955. (H.M.S.O. Code No. 56-20.)

DEVELOPMENTS IN SWEDEN

Bureau de Presse Suédo-International, Stockholm, February 1957.

The first permanent television relay was completed recently with the installation of a directional antenna on the L. M. Ericsson radio tower, in Stockholm. The transmitting-receiving station is some 16 miles distant. Wavelength is 6 cm., frequency is 5,000 Mc/s., and power 5 watts. The antenna, made of aluminum, is 5 m. high by 3 m. wide and weighs 600 kg. The curvature of the antenna reflector was calculated on a new electronic machine of the Saab organization. Tolerances during construction were not allowed to exceed 0.05 mm. on lengths of 2 to 3 metres; this accuracy precluded field assembly, and the complete unit was successfully installed using a helicopter.

Kaplan Turbines Ordered — The State electricity authority has recently ordered two Kaplan turbines, with a combined capacity of 160,000 kw., from Nydqvist & Holm (Nohab), of Trollhättan. These will be the most powerful of their type in the country, and will be installed at the Porsi hydro-electric station, on the Lule river, in northern Sweden, as the first stage of the planned three-turbine installation. The net head will vary between 33 and 36 metres; maximum output, at 36 m., will be 131,000 h.p., and annual power production will reach 960 million kw. The Porsi station is due to operate in 1960-61. Cost is estimated at $23.7 million.

Stockholm Airport The new international airport for Stockholm, to be situated at Skå-Edeby, 15 miles from the city centre, will involve capital investments of some $35 million; in addition, Scandinavian Airlines System is to spend some $25 million for new hangars, offices, and so on. In the first stage, to be completed in 1960, the main runway will be 2500 m. long, to be extended to 3300 m. and finally to 4000 m.

ABSTRACTS OF PAPERS PRESENTED TO THE INSTITUTION OF ELECTRICAL ENGINEERS

The remote and automatic control of semi-attended broadcasting transmitters. R. T. B. Wynn, C.B.E., and F. A. Peachey. (No. 3276)

In the chairman's address to the Radio Section in October 1949 a description was given of the steps that the BBC was taking to extend its sound broadcasting service, without a proportional increase in the number of its technical staff. This was being achieved by a process which now might be termed "automation" but which at that time meant broadcasting from unstaffed transmitters remote from the studios supplying the programme material.

This paper reviews this technique and may be regarded as confirmation that these steps were justified.

138 kv. submarine power cable interconnecting the mainland of British Columbia to Vancouver Island. T. Ingledow, M.E.I.C., R. M. Fairfield, E. L. Davey, K. S. Brazier, and J. N. Gibson. (No. 3306)

The paper describes the carrying out of the 138 kv. a.c. submarine power cable project between the mainland of British Columbia and the island of Vancouver for the British Columbia Electric Co. Ltd. (B.C.E. Co. Ltd.).

The supply system of the region involved and the requirements necessitating the installation of a submarine power cable are described. The considerations leading to the adoption of the pre-impregnated gas-filled type cable, provided with a hollow conductor, and made in continuous lengths up to 16 miles are discussed and this is followed by the engineering development, design, proving, and performance of the cable and accessories from the electrical, mechanical, pneumatic, and corrosion aspects.

The manufacture of the cable and the development, design, and installation of the special plant necessary for the continuous length manufacture of strand, lead covered, and finished cable are described in the next section. Noteworthy items are large turntables for storing strand and lead covered cable, a length storage mechanism to link up the paper lapping machine and the lead press for continuous manufacture, and the coiling down shed for the storage of 90 miles of finished cable.

The transport and installation of the cable and acessories are dealt with in the penultimate section. Descriptions are given of the transport to site, the main crossings and landing sites, the laying of the main cable lengths by cable ship, and the scow method of landing the shore-ends. The reasons for the adoption of these methods are also given and the section concludes with a brief note on the testing, gassing and commissioning of the cables.

Earth electrode systems for large electric stations. J. D. Humphries. (No. 3275)

Interconnected systems have increased considerably in recent years, and the large possible earth fault currents resulting require further thought being given to earth system design, especially in areas of high soil resistivity. The paper discusses the special practical problems of the design, construction, and testing of earth electrode systems for stations with possible maximum earth fault currents in excess of 3 kilo-amp. The basic components are reviewed in some detail, and principles of design are suggested for power station and large substation earthing installations. Several examples are considered in detail and brief notes are given of a number of other stations. The measurement of soil resistivity and of the dissipation resistance of large earth electrodes is discussed and new techniques of resistance measurement which have been specially developed for use with large installations are described.

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

Progress by NYSPA

During February, progress continued on all features of the project. Overall construction is on schedule as concrete placement to date exceeds 925,000 cubic yards and excavation for all features exceeds 35.5 million cubic yards. Employment averaged 2,600 for the month.

At Long Sault dam, excavation of the upstream plug was suspended one week on February 12, due to an ice jam. Rock for construction of cofferdam E continued to be stockpiled.

Concrete placement in the powerhouse at end of February exceeded 452,000 cubic yards. Erection of the 300-ton gantry crane was started and placement of concrete foundations for equipment and structures in the 115-kv, switchyard and the transmission line was progressing rapidly.

At Iroquois dam, unwatering of the stage 2 cofferdam area was completed and excavation was started within this area. Approximately 90 per cent of the upstream stage 1 dike had been removed.

At Massena intake, removal of the upstream and downstream diversion plugs progressed on a 24-hour basis. The 48-inch permanent water pipe line was placed in the gallery. Installation of the electrical and mechanical equipment inside the structure continued.

Excavation under the five channel improvement contracts had progressed to approximately 60 per cent of completion, as excavation continued under three of the five contracts. Continued progress was being made by the reservoir clearing contractors, as 3,300 acres of the required 11,000 acres had been cleared to date. Clearing of the right-of-way for the Barnhart - Plattsburgh transmission line was 85 per cent completed. The contract for fabrication of the 200-Mva auto transformer was awarded and six bids were received on February 14, for the construction of the line. Specifications were being prepared for the completion of Richards Landing dike and the bridges in the village of Waddington. Close inspection and expediting was continued on the major items of equipment being manufactured at various plants. An on-the-spot supervisory check had been completed in various European plants fabricating components to insure their delivery on schedule.

Progress by Ontario Hydro

Moderate weather conditions prevailed throughout February. The total number of workers on the Ontario Hydro section of the project at month end was 3,650 persons.

Excellent progress was made on all

The St. Lawrence power dam. Canadian construction operations are seen in the foreground.

phases of the power-house. Approximately 470,000 cubic yards of concrete had been put into the main structure by month-end. Concrete placing had been completed for the first seven draught tubes and work was in progress on the eighth.

More than half the concrete had been placed for the scroll case for No. 1 generating unit. Installation of turbine units for the generating station also was in progress. Casings for three of the turbines were in place, and work was started on the fourth turbine.

After an idle period of two months, work was resumed on Cornwall dike. Rip rap was being placed on the upstream slopes in section three and more than 1,000 feet had been completed. Excavation also was in progress on the marine clay crossings.

At the beginning of February, the plug was opened and water was let into the mile-long diversion of Cornwall canal. All the plug was removed and excavation for the turning basin at the east end had virtually been completed. Cofferdams were being constructed across the old canal west of this turning basin and immediately west of where the dike will cross the old canal.

Large scale reservoir clearing of trees had commenced. Approximately 2,400 acres in the headpond area were cleared at month-end. The section cleared represents the most densely wooded area and is about 40 per cent of the clearing.

Channel improvement work had been progressing on schedule. About 9,000,000 cubic yards of earth and some 850,000 yards of rock had been removed by month end at Galops Island. At Iroquois Point, approximately 1,000,000 cubic yards of earth had been excavated. Three contracts totalling $13,432,357 were awarded for channel improvement work in the vicinity of Cardinal and Morrisburg, Ontario.

Hydro's 1957 schedules

By the end of March, the flow down the Long Sault rapids was to be halted by a rock and earth filled temporary cofferdam. The river water in the main part of the stream then would be diverted through a wide man-made channel excavated across adjacent Long Sault Island and then into the river's south channel. This work was being done to permit the building of the second stage of the concrete Long Sault dam.

Year-End Goals

Approximately 71 per cent of the power-house is scheduled to be finished by the end of 1957. Installation of the first generator will be started in mid-summer by the Canadian General Electric Company. Canadian Westinghouse Co. Ltd., will begin erecting its first unit in the fall. These two firms are the suppliers for the sixteen generators to be installed in the Canadian half of the International power-house. Each firm has eight units to supply.

Associated electrical work, such as installation of the switchgear and heavy current-carrying conductors, is scheduled for the end of this year. Installation of transformers will commence in the spring of 1958. A new feature will be the first Hydro installation of 230-kv underground cable. The cable will carry the power from the transformers at the power-house to a terminal structure, and the power will be taken from there by overhead lines to the transformer station, two miles to the north. These cables are being made in Britain. The longest one will be 2,200 feet.

Nearly 90 per cent of the power-house headpond is scheduled to be cleared. Cornwall diversion canal and dike closure will be completed and in operation early in the year. This will enable ships to sail without interference through the power-house area during the 1957 navigation season. Likewise, trains will be running over the 40-mile stretch of relocated CNR double track that will be completed this summer. Highway No. 2 will be relocated along the 40 miles between Iroquois and Cornwall. A major part of the relocated highway will be paved and in use.

All house-moving will be essentially completed in 1957, involving a total of approximately 500 houses transported to new townsites. Work will be in progress in the three new communities and the new subdivision in Morrisburg. Clearing of abandoned townsites will be underway and should be well advanced. The new St. Lawrence transformer station will be ready early in 1958 to take power from the first four units of the new generating station. By year end area transmission lines will be about 90 per cent completed for the distribution of power into On

Iroquois dam. Excavation operations are being carried out in the Stage II construction area.

tario Hydro's grid system. At Galops Island, Chimney Island, Iroquois Point, Point Three Points, and Cardinal Channel, the excavation work will amount to a total of some 21,350,000 cubic yards and will be about 73 per cent completed.

Ontario Hydro Providing 7-day Tour Service:

Interest in Hydro's St. Lawrence power development is expected to reach record proportions this year.

As a result it has been decided to resume tour service every day in the week. Beginning in March tour guides will be on duty at Hydro's project information centre throughout the week and on Saturdays, Sundays and holidays. Mondays through Saturdays, the tour hours are 9.00 a.m. to 4.30 p.m.; on Sundays and holidays, the hours are 1.00 p.m. to 4.30 p.m.

Progress By SLSA

Progress during the month of February was mainly confined to work on the five locks and on the south shore ends of the Jacques Cartier, Honore Mercier and Caughnawaga bridges. Total employment amounted to some 3800 persons. Work on all locks was on schedule.

At the Iroquois lock the headgates were all poured and work was proceeding on the chamber section. Bases for ballards were being set and sluicegate guides were being placed. Excavation had been started at the downstream end of the lock. Four million yards of excavation had been done up to the end of February and 174,000 cubic yards of concrete poured.

At Beauharnois the tunnel under the lower lock was being poured, with 29,000 cubic yards placed by month-end. Rock excavation to date amounted to 365,000 cubic yards. At the upper lock 345,000 yards of common excavation and 430,000 yards of rock had been removed but no concrete had been placed up to the end of February.

No concrete was placed during February at the Cote St. Catherine lock. 1,500,000 yards of common excavation and 1,200,000 yards of rock had been removed to the end of the month. At the St. Lambert lock the contractor was just getting ready to resume placing of concrete, with none poured during the month of February. Over a million yards of rock had been taken out to date.

At the Jacques Cartier bridge jacking up of the superstructure was proceeding, with traffic diverted to temporary lanes in both directions. Work on the bridge piers, already nearing completion, had been suspended for the winter, while a start had been made on the new south abutment. The south end approach embankments at the Mercier bridge and the footings for the wood trestle were pretty well completed. Excavation under the Mercier and Caughnawaga bridges on the south shore to date totaled 200,000 yards of common excavation and 253,000 yards of rock.

A contract for dredging and channel improvements in both the north and south channels at Cornwall Island, near Cornwall, Ontario, was awarded January 31 to Marine Industries Limited, Montreal, at $13,411,000. Under this contract common dredging in the south channel will amount to 1,500,000 cubic yards; common dredging in the north navigation channel, 980,000 cubic yards; rock dredging, 5,000 cubic yards and common excavation, 2,860,000 cubic yards.

On the same date a contract was awarded for the superstructure of a single track railway swing bridge over the Beauharnois canal to Bridge and Tank Company of Canada, Ltd., Hamilton, Ont. This contract is valued at $508,370. Completion is called for by May 1, 1958.

As previously announced, the dredging and excavation work in the south channel has been divided between SLSA and SLSDC. The Canadian portion will extend from the present Roosevelt Bridge, downstream for three and a half miles. This navigation channel will be built in two stages. Initially, it will serve 14-foot navigation which must be diverted through the two United States locks as of July 1, 1958. The second stage will involve the deepening of this section to the required 27 feet. Under this contract a mile of dredging will also take place in the north channel.

By July 1, 1958 dredging specified for 14-foot navigation in the south channel is to be completed. By October 31, 1958 the whole of the work in the south channel is to be completed to 27 feet and by November 30, 1958, the whole of the work shall be entirely completed. The seaway is to be opened to shipping at the beginning of the navigation season of 1959.

New Victoria Bridge Span Ready by Mid-1958

The final phase of the face-lifting on Victoria bridge will begin this spring, and with completion some 18 months later will end what was for many years the "horse and buggy" tradition of the span. Final modifications at the St. Lambert end will mean multiple access for both trains and motor vehicles. Traffic on both rails and road will be continuous, as will be the movement of ocean vessels through the St. Lambert lock during the navigation season.

NYSPA Power Sale

New York State Governor Averill Harriman in mid-February agreed to approve a contract whereby NYSPA would sell 239,000 kw. of seaway power or some 25 per cent of New York's share to Reynolds Metals Co. Reynolds plans to build a 100,000 ton aluminum reduction plant costing $88 million near Massena. The Authority expects Congress will permit it to build a 1,800,000-kw. station at Niagara. If it gets the Niagara license it must borrow $566 million; thus it needs firm contracts as an inducement to bond buyers. The deal with Reynolds is just such an inducement. Tying the seaway and Niagara power systems together, as the Authority plans, would increase the firm supply of kilowatts available at each by letting them share reserve capacity needed for peak loads. Integrating both with private utility steam plants would enhance the whole States power picture.

Authority Chairman Robert Moses has defined a 150-mile radius from Barnhart Island as the boundary of an area that could be economically served by seaway power. His first deal was with Alcoa for sale of 239,000 kw, to replace Alcoa's present power facilities which will be flooded out by the seaway. Now it is proposed to dispose of 239,000 kw. to Reynolds and 143,000 kw. to Niagara Mohawk Power Corp.

The Alcoa plant employs 6000. Reynolds, though it will only employ some 1200 persons, will probably bring a fabricator into the area as well. General Motors Corp. will build an aluminum castings foundry for Chevrolet next to the Reynolds plant to employ 500. Thus manufacturing employment in New York State, which has been declining, is due for a boost.

New Lakes Diversion not serious

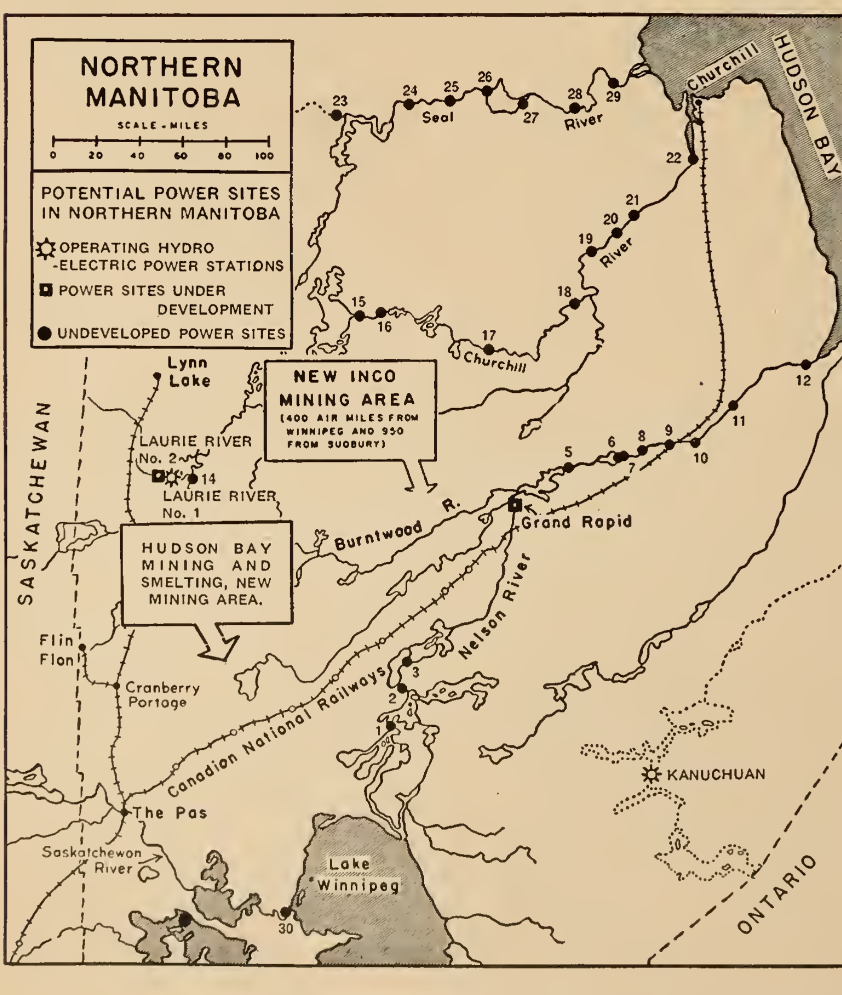
U.S. Army Engineers in charge reported in mid-February that increasing the diversion from Lake Michigan by 1000 cubic feet per second over a three year period would not greatly affect the levels of the Great Lakes. Lakes Michigan and Huron would be lowered ⅝ in. and Lakes Erie and Ontario ⅜ in. The affect would disappear in about fifteen years. Lowering of levels could be partly compensated for. Lowering levels could reduce output of power by a small fraction of one per cent. It would adversely affect navigation slightly during low lake stages, but the effect is so small and temporary that its effects could not be evaluated in monetary terms. Permanent diversion of 1000 c.f.s. would lower Lakes Michigan and Huron only one inch and Lakes Erie and Huron only ⅝ of an inch.

Northern Manitoba Resources

Great attention has been directed recently to the resources of northern Manitoba, in particular to the water powers. This was brought into focus by the recent joint announcement by the premier of the province and the president of International Nickel Company of Canada Limited concerning the establishment of an immense nickel industry in the Mystery-Moak Lake area. (Reported in the February 1957 issue of the Journal)

Eighty-five percent of the water power resources of Manitoba, or about 4½ million horse power, are located in northern Manitoba, or north of latitude 53. Less than one quarter of one percent of these resources, less than 9000 hp., have been developed, to date. Present developments comprise a hydro electric station of 7000-hp. capacity on the Laurie River, (built to serve the mining requirements of Sherritt Gordon Mines Limited at Lynn Lake) and an installation of 1,900-hp. on the Island Lake River, built some years ago.

Two sites are under development.



(1) The 7000-hp. plant at No. 2 power site on the Laurie River is meant to provide additional power for the Lynn Lake mine of Sherritt-Gordon Mines Ltd. Completion is scheduled for October 1957.

(2) The Grand Rapid power project on the Nelson River is being developed by Manitoba Hydro Electric Board. Power from this source will supply the International Nickel Company's mining operations in the Mystery-Moak Lake area. Completion is planned for 1960.

Undeveloped potential water power sites in Northern Manitoba can be listed as follows: Nelson River, 12 sites totaling 2,967,000 hp., the Churchill River, 10 sites, 1,006,300 hp.; Seal River, 7 sites, 151,460 hp.; Saskatchewan River, Grand Rapids, 150,000 hp.; other rivers, 192,000 hp.

The Saskatchewan River, Grand Rapids site represents a "probable" future source of power for southern Manitoba. This is interesting in view of the fact that harnessing of southern Manitoba water powers is virtually complete, with 762,000 hp. of generating capacity installed. Mainly, increased supplies would be met from thermal generating stations or by transmission over considerable distances.

While metals are seen first in looking at northern Manitoba's prospects, other factors take on importance, also,—eg. commercial fishing, the tourist industry, agriculture. The pulp and paper industry has received an impetus from the Grand Rapid power development on the Nelson River. This area, it is reported by the Department of Industry and Commerce of Manitoba, can offer a combination of favourable economic factors for this industry. These are listed as adequate power, existing railway facilities to the south and north, sufficient and economical wood, a long cutting season, a fair supply of labour, and acceptable townsite legislation.

Flin Flon Developments

Shaft sinking and underground development work will be started during 1957 in the Snow Lake area of Manitoba.

The Hudson Bay Mining and Smelting Co. Ltd., continued its active prospecting in the general vicinity of Flin Flon in 1956. There were discoveries of two new mineral deposits of major significance near the town of Snow Lake, Man., one of which is at Chisel Lake 5 miles to the southwest, and the other at Stall (Miller) Lake, 4 miles southeast of the town.

The Chisel Lake property has predominant zinc values with lesser amounts of gold, silver, copper and lead, while the Stall Lake property has predominant copper with lesser amounts of other metals. The company also owns another copper mine property at Osbourne Lake, 12 miles northeast of Stall Lake. This has been developed by diamond drilling.

Production from this new area will be treated in the metallurgical plants of Hudson Bay Company at Flin Flon, so that known ore reserves will extend operations there for many years. In addition to the discoveries already made in the Snow Lake area, the company has a further intensive program of exploration work under way, and is searching by geophysical methods and diamond drilling, over large areas, under option or claimed, for additional ore deposits. The recent discovery of sizable base metal ore deposits in this new district represents one of the major mining discoveries of recent years in Manitoba.

Canadian Pipeline Projects

Trans Canada Pipelines

Throughout February crews were clearing and levelling right of way between Pense, 15 miles west of Regina, and Winnipeg. Other construction operations, practically shut down from mid-December to the end of January, were resumed in part during February. Price-Poole had set up headquarters at Crandall, Manitoba, and was setting up a new type of semi-automatic jointing yard there. Welding was started at the end of January and the current rate during February was about 50 joints daily.

Pipe deliveries had been almost competed for the 34-inch line to the Red River by the end of February, and stringing was completed on sections 3 and 4. Clearing and brushing on these two sections were completed, as well as on most of section 5 and a third of section 6. Pipe was being strung out of the Price-Poole jointing yard as fast as it was stockpiled from the machine. The double jointing yard on section 6 will be reopened by early March.

Work on river crossings was resumed in mid February. No start was planned on the crossing over the Red River at St. Norbert near the end of the 34-inch line until Miniota and Portage La Prairie crossing were in.

Trans Canada officials predict almost 60 per cent of the entire pipeline will be completed this year. Work on the 34-inch western leg will resume as soon as weather permits, with natural gas due in Winnipeg September 1. Eighty-five miles will be laid this year from there to the Ontario boundary, while Trans Canada will supervise construction by the Crown Corporation of 310 miles of 30-inch pipe to Port Arthur. Trans Canada will also lay 308 miles of 20-inch pipe this year from Toronto to the west end of the Island of Montreal. Welland tubes have commenced manufacture of the 20-inch pipe for this stretch.

Alberta Gas Trunk Line Co.

Alberta Gas Trunk Line Co. plans to lay 100 miles of 18-inch line and 18 miles of 34-inch line during the current year, to connect up the Provost, Bindloss and Sibbald fields with Trans Canada's main line. They completed financing for some $13 million during February. Work on this gathering system is already under way. By 1960 the company expects to have a 500-mile gathering system costing some $54 million, capable of moving 620 million cubic feet daily. Addition of compressor stations would boost capacity to 800 million cubic feet daily.

Northern Ontario Pipeline Crown Corporation

Trans Canada Pipeline officials are not fully satisfied with the Crown Pipeline Corporation's arrangements for building the 30-inch section of the project over the Northern Ontario section from the Manitoba boundary to Kapuskasing, and want to do the engineering themselves. Tenders closed on March 1 for clearing over this section. As of February 22 no deliveries of the 30-inch pipe for this stretch had been made.

The Crown Company was reimbursed at the end of February by Trans Canada for the $50.7 million advanced to Trans Canada at various times last year. Effective March 1, 1957, J. C. Lessard of Montreal, and J. W. McKee and Dr. G. S. Walters of Toronto replaced Marc Boyer, R. G. Johnson and M. W. Sharp of Ottawa on The Board of Directors, of which D. A. Golden, Deputy Minister of Defence Production, is President.

Sale of Montreal Gas System

An option to purchase the gas distribution system and related facilities of Hydro-Québec in the Montreal area for some $35 million is held by Quebec Natural Gas Corporation. A Trans Canada contract with this company calls for initial deliveries of 30 million cubic feet per day (whether from Tennessee Gas Transmission or Trans Canada) and progressive increases in this volume to 102 million cubic feet daily by October 1963, and to 112 million thereafter. Peak sale of manufactured gas in the Montreal area at present runs about 35 million feet daily. The Quebec Legislative Assembly gave final approval on February 21 to a government bill authorizing the sale.

$200 Million Financing

Besides the $25 million initial financing for Quebec Natural Gas to be marketed early in April, there are many other offerings totalling about $90 million pending within the next three months. Largest of them is for Union Gas Co., which expects to raise some $35 million. This company faces the biggest expansion move in its history, which will triple its operations over a few years. Delivery of 140 miles of 26-inch pipe is assured by August to be laid from the Dawn Township storage field to Hamilton, at a cost of between $22 and $25 million.

Next in size is the Northern Ontario Natural Gas Company's $25 million offering, expected about the end of March. This company's various distribution systems will cost them some $32 million. Construction of systems for Kenora, Dryden, and Lakehead cities will be started early during the coming summer, while next year the company will lay distribution systems for communities from Kapuskasing to Orillia, including those for Bracebridge and Gravenhurst, as well as the 82-mile lateral from North Bay to Sudbury.

Consumers' Gas Co. of Toronto have a $50 million expansion program under way, on which they have already spent $25 million and plan to finance $5 or $6 million this year of the remaining $25 million. The Public Utilities Commission of Kingston is considering an offer by Consumers' Gas Co. to spend $5 million in developing a natural gas distribution system, which would take five years

Cobweb of wire rope carries the 30-in. tube of Westcoast Transmission Company's gas pipeline over the Fraser River at Shelley, B.C.

to complete. Consumers' would be awarded the franchise.

Lakeland Natural Gas, which holds franchises in 18 central Ontario municipalities, plans a 3 year expansion program costing $13 to $18 million, and will finance sometime this year.

Winnipeg and Central Gas Co. is already well embarked on its $20 million expansion program.

Westcoast Transmission

Work on the Westcoast Transmission pipeline was continued during the winter months, and pipe laying, construction of compressor stations, aerial crossings and other installations were well ahead of schedule in mid-March, with more than 600 men at work. Pipe laying on sections 3 and 4 in central and southern B.C. was carried out during the winter, and full-scale laying was scheduled to start shortly after the first of April.

Work was underway on the four compressor stations planned for this year. The first three were more than one-third complete, and foundation work was proceeding on the fourth. All engines and compressors for Station No. 1, located at Taylor, were delivered and were on their foundations, while the engines for Station 3, near Fort McLeod, and Station 5, near Quesnel, had been delivered. The major aerial river crossings over the Peace and Fraser Rivers at Shelley and at Quesnel, were completed.

Main line pipe installation was more than 71% complete. Nearly 90% of the main line pipe had been received. The northern 120 miles of the line had been completed in December, and plans were underway to test this section with natural gas from wells in the nearby Kiskatinaw gas field. Four-inch pipe was being laid from this field to the mainline. The double-jointing plant had been established near Prince George, and would resume its operations in March.

The Company foresaw no delays in construction during the coming season, and expected gas to be flowing through the line before the Fall of this year. Initially the pipeline will carry 400 million cubic feet of gas a day. By the addition of further compressor stations, the capacity can be increased to 660 million cubic feet a day. Total cost of the present project is $170 million.

Westcoast is establishing its operating headquarters in Vancouver. Divisional operations will be centered at Fort St. John, Prince George, and Savona, B.C., with maintenance sections located at intervening points along the line.

Saskatchewan Developments

Two power stations are under construction by the Saskatchewan Power Corporation, one at Estevan and one at Saskatoon, each to produce 264,000 kw. when completed. Each station will cost approximately $40,000,000, and when in operation they will establish complete integration of the provincial power system.

The Saskatoon plant is being built on the southwest corner of the city on the bank of the South Saskatchewan River, and will cover 85 acres of land. It will house four 66,000-kw. steam turbine generators, the first to be commissioned in the spring of 1958. The first two generators are on order from the Brown Boveri Company and the English Electric Company.

Coal and oil will be the main fuels, with natural gas from the nearby gas pipeline being utilized for off-peak generating purposes.

Two steam boilers are now on order from Foster-Wheeler Co. Ltd., in St. Catharines, Ont. They are designed to produce 600,000 pounds of steam per hour each, and are the largest boilers ever installed in Saskatchewan. In the water pumping plant there will be an initial installation of two pumps, each with a capacity of 66,000 gallons per minute.

At Estevan it was necessary to design a dam at Long Creek in order to provide a reservoir of cooling water for the new station, to be constructed on the bank of the creek. The dam will be an earth-fill type, one of the largest constructed in the province and the first of its kind built by the SPC for use in conjunction with thermal power production.

When completed, the reservoir will contain some 50,000 acre-feet of water with a surface area of approximately 2,000 acres. The maximum water level of the reservoir under these conditions will be reached at a height of 1,840 feet above sea level.

This level ensures that there will be no unwarranted increase in the water level of Long Creek across the international boundary.

Power produced by the Saskatchewan Power Corporation in 1956 is reported as 622,676,923 kwh.

The commission's new $1,500,000 gas engine generating plant at Kindersley was officially commissioned in November adding a total of 9,000 kw. to the northern integrated system. The largest internal combustion engine generating station in the province, it uses natural gas from the Brock-Coleville fields.

Work has already started on an $1,800,000 extension, to be in operation by the end of 1957. It will house two Brown-Boveri gas turbine units, each with a capacity of 8,000 kw., bringing the total capacity of the plant to 25,000 kw.

At the A.L. Cole plant in Saskatoon, in 1956, a 33,000-kw. steam generating unit was supplied by C. E. Parsons of England. This addition raises the capacity of the plant to 105,000 kw.

Mining

Production from all the uranium producers in Saskatchewan is expected to reach a value of $54,000,000 during 1957.

In the Beaverlodge area, April 1957 will mark a large increase in milling facilities. Eldorado Mining and Refining Limited will have increased their milling capacity to 2,000 tons per day. Lorado Uranium Mines Limited, having made progress with mill construction, expected to be in production this month, with a capacity of 700 tons per day. Gunnar Mines Limited had increased their rated capacity to 1,650 tons per day by the end of 1956.

The Hudson Bay Mining and Smelting Company Limited, Flin Flon, continued to be the only producer of base metals. This company produces from both the Manitoba and Saskatchewan sides of the border, with the bulk of its production coming from Saskatchewan.

Exploration for potash in the province continued at an increased pace during the year. The Potash Company of America announced plans for the beginning of construction in 1957 on their $20 million surface plant. Production is expected to commence by the fall of 1958 at the rate of about 4,500 tons of ore per day. There are a total of 18 companies and five individuals holding Crown rights in the province. Represented are all the major potash producers from New Mexico as well as German and French interests. By the end of 1956, 3,500,000 acres of Crown owned mineral rights were under exploratory disposition for potash.

There was an increase in the quantity of sodium sulphate produced in 1956 to approximately 180,000 tons. Western Clay Products Limited began construction in 1956 on a vitrified clay products plant at Regina to utilize clay from Eastend. Salt production at Unity was more than 40,000 tons in 1956.

Saskatchewan lignite coal production from the Estevan-Bienfait area set a record year in 1956, with coal production amounting to 2,343,000 tons. The plans for the Estevan thermal power plant to use 2 million tons of coal per year, will greatly increase the coal production in this area.

What Goes On

Canadian Pacific Railway Company

Canadian Pacific Railway has instituted an integrated data processing program with the establishment of a Trans-Canada network of data centres and a computer centre in Montreal. Each data centre receives information by teletype from local points in its area. This is fed into a transceiver for transmission to the computer centre for processing.

Canadian Pacific Communications have provided the necessary telephone channels for transceiver operation and the telegraph channels for the extensive teletype network which also supplements transceiver transmission to and from the computer centre.

Canadian Industries Limited

C-I-L reports the ammonia plant at Millhaven, Ont., is in the final stages of construction. Production capacity of the $9 million plant will be 200 tons per day.

Construction began in early 1957 on the sulphuric acid plant at Copper Cliff, Ont., with completion expected in 1958. The investment was $3 million. Three hundred tons per day will be produced, using smelter fumes from International Nickel Company's iron recovery plant.

A plastics research laboratory is to be completed early in 1957 at New Toronto; later in 1957 a hydrogen peroxide plant at Hamilton will be finished.

An aerial view of Lorado Uranium Mill, under construction in the Beaverlodge area of northern Saskatchewan.

Shell Oil Company of Canada, Limited

A tanker of 40,000 tons deadweight will be built in Canada at an estimated cost of nearly $11 million and will join the Shell Canadian Tankers fleet in 1960.

Davie Shipbuilding Company of Lauzon, Quebec, will build the 710-ft.-long tanker for Papachristidis Tankers Limited, a Montreal corporation.

On completion the tanker, to be named "Canada Shell", will be turned over to Shell Canadian Tankers on a 20-year bareboat charter. Shell will man, manage and maintain the vessel.

Ontario Hydro

Response to the largest bond issue, $100 million, ever floated by Ontario Hydro was reported in March as gratifying.

Proceeds from the bonds will cover expenditures by the Commission during the coming extensive summer construction period. Altogether 10 separate projects are newly authorized.

The Commission will have, in the spring of 1958, a large scale electronic Univac II computer installed in the head office building in Toronto. The transition from the present to new methods will be gradual. The computer will be engaged primarily in commercial data processing and will also handle certain scientific and engineering computations.

Employees are following classes in electronic data processing. The first of several classes will comprise fifty planning personnel who will help to integrate the new "office automation" system on a step-by-step basis.

Dominion Bridge Company

Dominion Bridge Co. Ltd., was confirmed as general contractor, at $11,099,672, for Contract No. 2, for the Second Narrows Bridge, at Burrard Inlet crossing, calling for superstructure of main and approach spans and reinforced concrete bridge deck.

Owner is British Columbia Toll Highways and Bridges Authority. Consulting engineers are Swan, Rhodes and Wooster, Vancouver.

English Electric Company of Canada

Contract for construction and installation of five 200,000-hp. turbines was awarded to English Electric Company in February.

The turbines are for the 1,000,000-hp. underground hydro electric project of Aluminum Company of Canada Limited at Chute des Passes on the Peribonka River in Northern Quebec.

The general contractor is Perini, McNamara, Quemont Construction Companies. The engineering on the project is done by H. G. Acres Company of Niagara Falls, Ont.

E.G.M. Cape & Co. Ltd.

E. G. M. Cape will be the general contractor, at $4,898,000, for the superstructure of the combined customs and immigration building at Wolfe's Cove, Que., for the Department of Public Works, Ottawa.

Consulting engineers are Leblanc, Montpetit and Dorval; and D. D. Clark, both of Quebec City.

New Schools of Engineering

Two new engineering courses will be in effect this year with the opening of classes in September. The universities offering, for the first time, engineering courses leading to the degree of bachelor of engineering, are McMaster and Carleton, both in Ontario.

Carleton, Ottawa

Professor Donald F. Coates, M.A. (Oxon), M.ENG. (McGill), M.E.I.C., assistant professor of engineering at McGill and consulting engineer, has been appointed director of the school of engineering at Carleton. Dr. C. T. Bissell, president and vice-chancellor, released this information recently.

Students entering Carleton next September in the first year of engineering will begin the new program.

The new Carleton course will be one suitable for those students interested in careers in design, development, construction, production and operation in the fields of civil, mechanical and electrical engineering.

Professor Coates said that Carleton is fortunate in having already a well established two-year certificate course, which it can expand into a four-year degree program.

Carleton's undergraduate curriculum, details of which will be announced later, will emphasize the engineering sciences but will include a sufficient amount of work in engineering design to illustrate the application of knowledge to practical problems. Students in the fourth year of the program will have the option of doing their design work in either electrical, mechanical or structural engineering. Eventually, this undergraduate program will be supplemented by a specialized graduate program in selected subjects.

While a member of the McGill faculty, besides obtaining his master of engineering, specializing in foundation engineering, Prof. Coates was active as consultant on seaway, power and building projects. He has published the results of some research and investigation work in several engineering journals.

McMaster, Hamilton

Dr. George P. Gilmour, president of McMaster University, made the announcement of the program offering four year courses in chemical, electrical, or mechanical engineering, engineering physics, and metallurgy. It is planned to enrol fifty first year students in September, 1957.

"The addition of engineering studies is a natural expansion of the scientific activities of Hamilton College", Dr. Gilmour said.

Dr. John W. Hodgins, B.A.SC., PH.D., F.C.I.C., is director of engineering studies and professor of chemical engineering. Formerly professor of chemical engineering at the Royal Military College, Kingston, Dr. Hodgins has been planning the courses and facilities for the new school.

Dr. Hodgins reported that engineering research is being planned as an integral part of the program, since a research atmosphere is necessary to staff and students alike. "The activities of engineers are having an ever increasing impact upon society," he said, "and since the current shortage of engineers has the effect of allowing recent graduates to move rather quickly into positions of responsibility, it is appropriate that about one-fifth of the course will consist of humanities and social studies".

The present first year engineering course will be discontinued in the spring of 1957. For the first year of the new courses, lectures and laboratory work will mainly be given in the new Physical Sciences Building. Nuclear engineering will be added to the curriculum as a graduate course as soon as construction of the nuclear reactor and the engineering buildings on the McMaster campus is completed. Several industries have already made generous contributions, and a special fund raising campaign is being planned to assist in the costly construction of engineering facilities.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE
ELECTIONS AND TRANSFERS

Recognition For The *Journal*

Recently it has come to the *Jour-* *l's* attention that a readership sur- y made by one of the well known nerican periodicals with a so called ınadian edition pointed up, ironic- ly enough, that *The Engineering urnal* is the most read technical iblication in Canada and also that om the advertiser's point of view e *Journal* gives a better value per ader than does the publication hich made the survey.

Naturally in a story of this kind l names will have to be omitted it suffice it to say that one of the g Canadian industries was solicited the American publication for ad- rtising and in order to prove what superior medium the American iblication was they made a reader- ip survey of twenty-five publications ostly published in Canada. They proached almost five hundred engineers to have them indicate on a questionnaire the order of their preference for the twenty-five publications.

The resulting figures are shown on a percentage basis representing the first and second choice of the engineers who responded.

From the Institute's point of view the most interesting fact is that the *Journal's* percentage was thirteen and its nearest competitor in the technical field had only four per cent. *The Engineering Journal's* showing was within two per cent of that of the two largest Canadian non-technical periodical publications in the country.

It is comforting to have this further assurance that among Canadian engineers *The Engineering Journal* is still their first choice in reading matter.

Consultants

This message is addressed in par- ular to the consulting engineers of ınada.

In the *October 1956* issue of the *urnal* it was announced that the stitute was endeavouring to bring e information on its register of con- lting engineers up to date. Over 50 engineers were contacted at that me and the information already on le was returned to them for revi- on. Most engineers have replied but ere are still some outstanding, in ldition to which we believe there ay be some additional firms in Can- da who have not yet registered with e Institute at all.

It is important that we have on ur register the names of all the con- lting engineers with some account f the work which they have done and the fields in which they are now interested. There are many instances of substantial contracts being given to persons whose names were submitted by the Institute to prospective clients. We believe the service is a valuable one to Canadian engineers and we would like to have our records absolutely complete.

If any consulting engineers who read this notice have not yet sent in the information which is required, it would be appreciated if they would do so promptly. If the standard form for information has not been received, please advise this office and one will be sent to you immediately.

This service is rendered in an attempt to show prospective clients that Canadian engineers are competent to do any class of work which may be required in Canada.

The service is absolutely free both to the client and to the consultant.

Nuclear Congress

The Engineering Institute of Canada was one of the organizations sponsoring the Nuclear Congress, held in Philadelphia in March.

The Congress was sponsored by several organizations with which the Institute has been in cooperation for many years. The list includes the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical and Petroleum Engineers, the American Society of Civil Engineers, the American Institute of Chemical Engineers, the American Chemical Society and others.

The Congress was made up of sev-

Cover Picture

The beautiful scene on the cover easily recognized as Banff Springs Hotel, is frankly an inducement to readers to attend the annual meeting at Banff, Alberta, in June. The program is given on Pages 450 and 451 of this issue.

Colour plates courtesy Canadian Pacific Railway eral parts, and brought together the different organizations that have been interested in the nuclear engineering field over recent years.

One portion of the Congress was the Second Nuclear Engineering and Science Conference, another portion was the Fifth Atomic Energy in Industry Conference and the third was the Fifth Hot Laboratory and Equipment Conference. In addition, the occasion marked the third International Atomic Exposition.

It is proposed to publish a report on the Congress in a later issue of the *Journal.*

Columbia River

This editorial, from the Daily Journal of Commerce, Portland, Oregon, *is reprinted as a further expression of opinion on the Columbia River Discussions. Editor.*

"Canada and the Upper Columbia"

The September 29 issue of *Maclean's Magazine,* one of Canada's most widely read magazines, contains an article entitled "The Coming Battle for the Columbia", Bruce Hutchison, author of the article, sets forth the Canadian viewpoint and a great deal of background and history leading to present negotiations over use of the water in the upper Columbia river.

Unfortunately for the United States, the history goes back to the days when this nation was a lusty, rapidly growing group of states with little thought of our future resources and little regard for anything that stood in the way of our growth.

The article points out one of our great blunders in the past, going back to the days when we coveted gold in Alaska. Along with the gold we desired Alaska's panhandle, which controls such rivers as the Yukon, even though nearly all of that river lies in Canada.

The common law of England had developed from the theory that no man has the right to diminish or damage the flow of that river to the detriment of another man downstream. The United States rejected any such theories, and bulled through its own concept of the time — that a nation has the right to do as it pleases with any water in its borders.

That is the way the matter now stands, and we cannot question the legality of any move Canada may make with the waters of the Columbia or any other river within her borders. We can only hope that Canada will be generous for other reasons, but to be realistic we must realize that she is well aware of the value of her hydroelectric power potentials and is not preparing to negotiate them away without some real inducement."

Institute Represented on C.E.S.S.

THE SECRETARIES MEET: This photo shows less than half the delegates who attended the annual meeting of the Council of Engineering Society Secretaries, held in New York in January 1957. In the second row from the front are some of the officers, right to left, Charles S. Doerr, executive secretary, The Engineers Club of Philadelphia, a director; Allan Putnam, assistant executive secretary, American Society of Tool Engineers, vice-president; Nelson S. Hibshman, secretary, American Institute of Electrical Engineers, secretary; T. J. Ess, managing director, Association of Iron and Steel Engineers, retiring president; L. Austin Wright, general secretary, The Engineering Institute of Canada, newly elected president; William P. Youngclaus, executive secretary, American Society of Quality Control, treasurer. The ladies represent the Women's Engineering Society.

The E.I.C. and the Students

President V. A. McKillop greets a group of Hungarian students who are now studying English preparatory to taking up mining engineering at Toronto. They were guests of the Engineering Society for the president's visit.

[T]he president presents Institute prizes [t]o students: above, at R.M.C. to Donald [J]ohn MacCaul, and at University of [T]oronto to Jan Alexander Norton; (right) [t]o Kenneth Bruce Culver at Kingston meeting.

[C]ounselling at Montreal. The Montreal Branch frequently brings high school [s]tudents to the Headquarters auditorium [f]or counselling sessions. This illustrates [o]ne corner of the auditorium on a recent [o]ccasion.

Annual General and Professional Meeting of The Engineering Institute of Canada

Banff Springs Hotel

Banff, Alberta

June 12-13-14, 1957

TECHNICAL PROGRAM

PETROLEUM

Exploration for Oil and Gas
Dr. J. G. Spratt, President, Triad Oil Company Ltd., Calgary

Drilling and Completion of Wells
Scoville Murray, Production Department, Imperial Oil Limited, Calgary

Transportation of Oil
D. M. Morrison, President, Trans-Mountain Pipe Lines Limited, Vancouver

Gathering, Processing, Transportation and Marketing of Gas
J. Dillon, Manager, Gas Department, Shell Oil Co. of Canada Limited, Calgary, and
B. F. Wilson, Vice President, Canadian Western Natural Gas Co. Ltd., Calgary

Oil Refining
C. W. Coote, M.E.I.C., Manager, Edmonton Refinery British-American Oil Company Limited

The Petrochemical Industry
J. H. Shipley, Vice President, Canadian Industries Limited, Montreal

The Peace River and Alaska Highway Gas Gathering System to Serve Westcoast Transmission Co. Limited
A. L. Berry, M.E.I.C., Principal Pipeline Engineer, Westcoast Transmission Company Limited, and
B. L. Moreau, JR.E.I.C., Production Engineer, Pacific Petroleums Limited

TECHNICAL PROGRAM

Calculation of Operating Guides for New Catalytic Cracking Process
H. F. Moore, Esso Research and Refining

MECHANICAL AND THERMAL POWER

Cold Temperature Tests of Flash Welded X52 Line Pipe
M. A. Sheil, Director of Metallurgical Research, A. O. Smith Corporation, Milwaukee, Wisconsin

300-ton Cornwall Powerhouse Gantry Crane
P. Pemberton Pigott, Assistant Mechanical Engineer, Generation Department, Hydro-Electric Power Commission of Ontario, and R. D. Mutch, M.E.I.C., Assistant Mechanical Engineer, Mechanical Division, Dominion Bridge Co., Limited, Montreal

The Canada-India Reactor
F. J. Bleakley, M.E.I.C., Manager, C.I.R. Project, Shawinigan Engineering Co. Ltd.

Battle River Steam Plant
J. N. Ford, M.E.I.C., Manager of Operations, Canadian Utilities, Ltd., Edmonton, and W. I. McFarland, M.E.I.C., Consulting Engineer, Haddin, Davis and Brown, Limited, Calgary

The New Saskatoon Station of the Saskatchewan Power Corporation
R. R. Keith, M.E.I.C., Assistant Power Production Superintendent, Saskatchewan Power Corporation, Regina

MINING

The Caland Project at Steep Rock Lake
Philip D. Pearson, Manager, Caland Ore Company Limited, Atikokan, Ont.

CIVIL

Wintertime Concreting in Canada
T. G. Clendenning, Hydro-Electric Power Commission of Ontario

Review of Current Winter Construction Practices
C. R. Crocker, Associate Research Officer, National Research Council, Ottawa

Planning of Recent New Towns in Canada
Prof. S. D. Lash, M.E.I.C., Head, Civil Engineering Dept., Queen's University, Kingston

Composite Construction
R. David, M.E.I.C., District Engineer, Canadian Institute of Steel Construction, Montreal, and Dr. G. Meyerof, M.E.I.C., Head, Department of Civil Engineering, Nova Scotia Technical College, Halifax, N.S.

Roof of the Shakespearean Festival Theatre
C. Hershfield, M.E.I.C., Assistant Professor, Dept. of Civil Engineering, University of Toronto.

Forces Involved in Pulpwood Holding Grounds
R. J. Kennedy, M.E.I.C., Associate Professor of Civil Engineering, Queen's University, Kingston

TECHNICAL PROGRAM

Experiences in Tunnelling Saskatoon's Fourteenth Street Storm Sewer Through Glacial Deposits

N. L. Iverson, M.E.I.C., Soil Mechanics Engineer, Prairie Farm Rehabilitation Administration, Saskatoon and D. R. Graham, M.E.I.C., Waterworks Engineer, City of Saskatoon

Kelowna Floating Bridge

W. Pegusch, JR.E.I.C., Design Engineer, Swan Wooster & Partners, Vancouver

Oak Street and Middle Arm Bridges

L. Osipov, Chief Designing Engineer, Phillips, Barratt & Partners, Vancouver

Location Problems in the Rogers Pass Route

J. P. Hague, Senior Location Engineer, Department of Highways, Victoria

ELECTRICAL

Future Power Development in B.C.

T. Ingledow M.E.I.C., Vice President and Executive Engineer, British Columbia Electric Co. Ltd., Vancouver

St. Lawrence Estuary Submarine Power Transmission System

O. W. Titus, M.E.I.C., Vice President and General Manager, Canada Wire and Cable Co. Ltd., Toronto

A Major Power Plan for Yukon River Waters in the Canadian Northwest

J. M. Wardle, M.E.I.C., Consulting Engineer, Northwest Power Industries Ltd., Ottawa

Some Effects of Fifth Harmonic Voltages, and their Mitigation, on the System of the Manitoba Power Commission

J. P. C. McMath, M.E.I.C., Professor and Chairman, Dept. of Electrical Engineering, University of Manitoba, and
Paul Shane, M.E.I.C., System Supervisory Engineer, Manitoba Power Commission

Recent Expansion of Canadian Overseas Telecommunication Corporation Facilities

R. G. Griffith, M.E.I.C., Chief Engineer, Canadian Overseas Telecommunication Corporation, Montreal

CHEMICAL

The Spouting of Large Solid Particles

Dr. G. L. Osberg, Applied Chemistry Division, National Research Council, and C. B. Cowan, and W. S. Peterson.

Design and Operation of an Effluent Disposal System

J. C. Langford, Manager of Engineering and Maintenance, Canadian Chemical Co. Ltd., Edmonton

Air Pollution Control at a Nylon Intermediates Plant

H. R. L. Streight, Engineering Department, Du Pont Company of Canada (1956) Ltd., Montreal

TECHNICAL PROGRAM

AERONAUTICAL

Facility for Testing Aircraft Gas Turbines at Simulated Conditions

P. K. Peterson, Chief Equipment Engineer, Orenda Engines Limited, Toronto

Engineering the RCAF Argus

Everett B. Schaefer, Assistant Chief Engineer, Canadair Limited, Montreal, and William K. Ebel, Vice President, Engineering, Canadair Limited, Montreal

GENERAL

Management Panel Discussion

Chairman, B. A. C. Hills, M.E.I.C.

DINNER ADDRESS

The Impact of Western Oil on the Canadian Economy

C. O. Nickel, M.P., Calgary

BANQUET ADDRESS

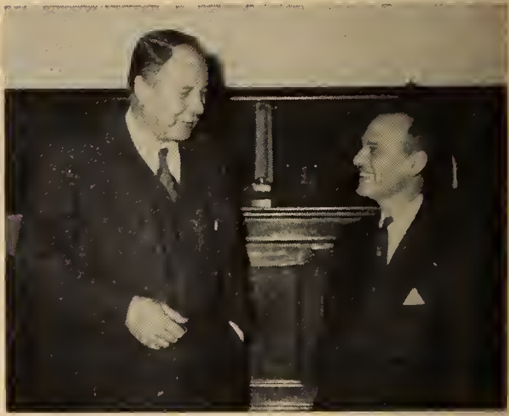
Mr. Justice S. Freedman, Winnipeg

- 34 Technical papers
- Unveiling of the Cambie Memorial Plaque
- Scenic bus excursion to Mount Norquay Lodge.
- Branch Officers' and Students' Conferences.
- Hospitality of Muriel's Room.
- Calgary Branch stage show—"Pipe Line Musical Review".
- Golf Tournament.

Athlone Fellowships. The Institute entertained Dr. H. H. Burness of the Ministry of Education, Great Britain, when he was here selecting candidates. Left to right, Dean R. E. Jamieson, Dr. Burness, Past-president R. E. Heartz, Dean Henri Gaudefroy, and Dean Emeritus J. J. O'Neill, of McGill.

Branch Events

Belleville Branch. Head table (left), including Councillor S. Sillitoe, President and Mrs. McKillop, and Vice-President and Mrs. H. R. Sills of Peterborough.



Montreal Branch (above). The retiring chairman E. D. Gray-Donald (left) hands over the chairmanship of the Branch to Leo Roy.

The Kingston meeting (above). "A good time was had by all". The head table (right) at Kingston. Left to right, His Worship Mayor F. P. Boyce, Mrs. McKillop, Col. C. W. Jones, Commandant, RCEME School, The President, Mrs. Jones, Air Commodore D. A. R. Bradshaw, Commandant, Royal Military College, Mrs. L. F. Grant, and Mrs. Boyce.

THIRTY-FIVE YEARS AGO

Comment on the Journal of April, 1922

Advertising has changed a lot in thirty-five years. By modern standards, that in the *Journal* for April, 1922, seems pretty dull and one wonders why anybody would read it. There was a total lack of colour and few illustrations; advertisers depended upon using as many varieties of type as they dared for pulling power, but the pull seems to have been there nevertheless, because most of the names I notice in 1922 are those of our advertisers of today, with the exception, of course, of the fairly numerous firms which have gone out of business in the meantime. Perhaps the modern advertiser pulls the long bow in praise of his wares as often and as far as the old timers, but he is more subtle and artistic about it.

Technical Papers

Of late years the *Journal* has not published prize-winning student papers; in 1922 it did. The position of honour at the front of the April issue for that year is occupied by E. R. Woodward's (JR.E.I.C.) paper on "The Lignite Briquetting Plant at Bienfait, Sask". This plant was built as a joint effort of the provinces of Manitoba and Saskatchewan and the Federal Government as part of an attempt to find better ways of utilizing the vast deposits of low-grade coal in the southern parts of the two provinces. Containing about thirty per cent moisture, the raw lignite quickly slaked to dust on exposure to the air and had a lamentable propensity for spontaneous combustion.

At the Bienfait plant the lignite was subjected to low-temperature carbonization and the char briquetted, producing a high grade, smokeless fuel. The yield of gas was expected to be great enough to operate the carbonizers and it was thought that valuable by-products could be recovered from the tar.

Although much experimental work had been done and a semi-commercial plant had given encouraging results, the Bienfait plant was not a success. It never got into satisfactory production. The jump from pilot plant to full scale operation was too great and made too quickly and with too many guesses and too little reliable information. Perhaps for political reasons, operation was begun too soon; there should have been more time to "get the bugs out of the process".

The failure of this scheme was a disappointment to all connected with it, especially as most of them felt that better results could have been attained had circumstances permitted. Oil and gas fuels and improved methods of burning lignite have reduced the appeal of any process of the benefication of the raw coal.

The second paper in this *Journal*, "Actuarial Factors in the Design of Irrigation Structures", by H. B. Muckleston, M.E.I.C., contained a lot of good sense and might be read to advantage by many engineers today. The author set himself the task of discussing the value of storage, its relation to runoff, capacity and unit cost curves and economic storage capacity. Some of these matters were approached from the angle of probability, and early use of that theory. This paper is worthy of permanent preservation, type of which, unfortunately, we get too few. No matter how useful and interesting at the time of publication, the value of most of our papers naturally and gradually fades as time passes.

In 1922 Winnipeg had just finished the Maryland Street bridge across the Assiniboine river, a two-span concrete arch of conventional design. This paragraph may be quoted from the paper describing it: ". . .A concrete bridge presents all exposed faces of one colour . . . These faces . . . disclose . . . irregularities; each . . . day's run of concrete . . . is . . . outlined in any exposed . . . surface; board marks have . . . different shades of grey; . . . any yielding of forms . . . results in offsets and waves; occasionally, rock pockets appear which must be covered by . . . patches". These words might be borne in mind by those who wish to turn out a good looking, as well as structurally sound, concrete job.

It is an odd fact that the author of this paper, J. F. Greene, M.E.I.C., nowhere in his paper gives any clue to the size of the bridge, beyond saying that it had a fifty-foot roadway and two seven-foot sidewalks, nor were there any illustrations from which dimensions could be obtained. The finished bridge is shown to be a graceful structure.

Leonard Medals Awarded

Among the editorials in this *Journal* is an account of the Leonard Medals for 1919, 1920 and 1921. These were the first awards of these medals, all made to members of the Canadian Institute of Mining and Metallurgy. The gold in the medals came from the Coniagas mine, 24.5 ounces having been recovered in the electrolytic refining of 41 million ounces of silver, truly only a "trace".

There was also a brief account of a series of "special water power lectures" at the University of Toronto. These had been arranged by Professor R. W. Angus, M.E.I.C., of the department of mechanical engineering. Three of the five speakers were Max V. Sauer, M.E.I.C., and T. H. Hogg, M.E.I.C., both of the Hydro-Electric Power Commission of Ontario, and Norman R. Gibson, M.E.I.C., of the Niagara Falls Power Company.

The Branches

The Vancouver Branch decided it could get along without any dues for the current year, though it didn't say how this eminently satisfactory state of affairs was to be attained. Was the Branch to live on its surplus or had it discovered a fairy godmother or perhaps a gold mine? The Branch also decided that the provincial Association of Professional Engineers might be gently requested to confine its activities to those connected with the administration of the British Columbia Engineers' Act and cease to trespass on the field of technical meetings and the like, which the Branch felt was its own preserve.

The Calgary Branch reported 101 members of all kinds. The Edmonton Branch was listening to another chapter in the perennial discussion of Alberta's tar sands. The thirteen other branches reporting in this *Journal* had little to say beyond noting the results of their elections, offering summaries of papers presented to them and retailing items of branch gossip.

R.DE L.F.

Month to Month section is continued on page 552

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Sec.-Treas., H. M. Whittles, 10 Wembley Dr., Sudbury, Ont

TORONTO

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Sec.-Treas., D. S. Moyer, % Canadian Radio Mfg. Corp 11-19 Brentcliffe Road, Leaside, Ont.

VANCOUVER

Chairman, S. S. Lefeaux; *Vice-Chair.,* P. N. Bland; *Executive* J. S. Ball, W. G. Heslop, T. F. Hadwin, J. T. Turner E. S. Hare, C. H. Maartman; *Treasurer,* R. H. Carswell.
Secretary, A. D. Cronk, 658 West 13th Ave., Vancouver, B.C

VANCOUVER ISLAND

Chairman, G. Griffiths; *Vice-Chair.,* H. Graham; *Executive* H. T. Miard, L. C. Johnson, W. G. McIntosh, A. F. Page
Sec.-Treas., J. A. Cowlin, 3340 Richmond Rd., Victoria, B.C

WINNIPEG

Chairman, N. S. Bubbis; *Vice-Chair.,* L. A. Bateman; *Executive,* J. Hoogstraten, R. N. Sharpe, J. B. Striowski, W. Wardrop, L. E. Poyser, R. T. Harland, J. P. C. McMat P. Shane, W. D. Hurst, A. Baracos, T. E. Storey, W. McQuade.
Sec.-Treas., C. S. Landon, P. O. Box 541, Winnipeg 2, Ma

YUKON

Chairman, A. B. Yates; *Executive,* C. E. White; *Treasurer* J. L. Motherwell.
Secretary, Capt. S. Thomson, H. Q. North West Highway System, Whitehorse, Y.T.

ONTARIO DIVISION

Chairman, A. E. Berry; *Vice-Chair.,* G. R. Henderson *Board of Management,* P. E. Buss, H. G. Conn, H. Sills; *Treasurer,* G. R. Turner.
Secretary, G. H. Rogers, % Engineering Institute of Canada 236 Avenue Road, Toronto.

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

QUEBEC

Salary Survey

The response to the December, 1956 Salary Survey was a little better this year with a 45 per cent return of 2782 replies compared to 39 per cent last year. The remuneration committee which has been sponsoring the survey ever since its inception in 1952 was quite pleased with the return although the results would have been more significant had the response been larger.

The statistics reflect that considerable movement was evident in engineering salaries last year. As a reasonable approximation it may be said that the increase during 1956 was about equivalent to that of the two previous years combined.

For the combination field of employment against year of graduation, consulting engineering, which combines the earnings of consultants and their employee engineers, is on top and slightly ahead of industrial engineering for the first ten years or so; the results for the consulting field are too erratic to permit continuation of the curve after that time. Utilities and Civil Service trail behind industrial engneering and the differential increases with time.

For the combination type of work against year of graduation, the executive curve is on top and points sharply upward. The supervisory curve slopes moderately upward and flattens at year 1930 or so. The non-supervisory technical curve moves upward only moderately and heads downward after year 1944.

The non-supervisory sales curve is close on the heels of the supervisory curve for the first 10 years; the results are too erratic to permit continuation of the curve after that time.

Membership

The membership committee is presently conducting campaigns in several different fields in its quest for new members. One of these areas of operations is the large employer of engineers. Our records show that approximately 30 per cent of the province's engineers are employed by only twenty large firms.

Over the years many representations have been made by the Corporation to management and engineering groups in various large concerns with varying degrees of success. With this experience as a guide, the committee set about to plan a campaign which with slight modifications, could be employed as standard procedure for each company.

Very briefly, a program has been devised which, to be successful, depends upon the co-operation and support of the three interested groups, namely management, Corporation members and prospective members.

The committee initially presents its case to the management for approval, and a list of all eligible individuals is requested. Contact is made with several Corporation members employed by the firm, and the membership sub-committee is formed. This sub-committee is invited to attend one or more regular meetings of the Membership Committee to equip them with sufficient information and literature for recruiting.

Liaison is maintained during the recruiting period between the main committee and the sub-committee, and a record is kept of the outcome of each individual case.

ONTARIO

Technician Registration

Guided by Dr. George B. Langford, head of the Department of Geological Sciences of the University of Toronto, the rapidly-growing force of engineering technicians in Ontario, currently estimated at some 30,000, are now being certified as such under a voluntary program initiated by the Association.

The first of its kind to be established in Canada, the program requires engineering technicians who apply for certification to be examined by a special panel of examiners and classified in five grades, determined by educational qualifications and technical experience.

Opportunity to Advance. In this method of certification, engineering technicians will be given an opportunity to advance through the various grades to Grade five, and could by further self-improvement, education and experience, become eligible for registration as a professional engineer. Such certification would tend to instill pride of accomplishment among technicians, and act as a form of recognition, encouraging more young men to train as technicians. It would also serve industry as a method of defining the upgrading of their technical employees, employment requirements and salary structure.

The Association is receiving an increasing number of applications for registration from persons who are not graduates of recognized engineering schools. Each of the applicants is given an examination program. At present there are more than 1,500 of these applicants on file. The program will be carried out by a special Certification Board and a panel of examiners appointed by the Ontario Association executive council.

A certificate will be issued stating that the person has been examined and granted a certificate as "Engineering Technician Grade . . .", and that this fact is recorded at the Association offices.

Not Affiliated with Association. It is pointed out that the technician will have no connection as a member of the Association, and that the application for certification specifically states that the applicant understands that the granting of the certificate does not hold with it any right to practise professional engineering.

In its experimental stages, certification will not be compulsory and the program will operate without legislation.

It is expected that a report on the progress and success of the certification plan will be given at the next meeting of the Dominion Council of Professional Engineers.

Classification of Technicians

I. *Engineering Technician (Grade 1)*

(a) Minimum educational qualifications:
The Ontario Secondary School Graduation Diploma (obtained at the end of Grade XII) or equivalent provided the applicant has taken the science and mathematical subjects of Grade XI and XII, and

(b) Practical experience
One year's experience in an approved engineering office.

II. *Engineering Technician (Grade 2)*

(a) Minimum educational requirement:
Grade XIII Technical, or
Grade XIII General Course, (English composition, English literature, algebra, geometry, trigonometry, physics and chemistry), or
The Advanced Technical Evening Class Certificate, or
The Ordinary National Certificate, and

(b) Practical Experience

Three years' experience for applicants who possess a Grade XIII Technical standing, or standing in the seven subjects of the Grade XIII General Course referred to above.

Five years' experience for holders of the Advanced Technical Evening Class Certificate, or for holders of the Ordinary National Certificate.

III. *Engineering Technician (Grade 3)*

(a) Minimum educational requirement:

Completion of one year of an engineering course in a recognized university, or

Completion of a two year Technical Institute Course, the admission requirement to which is complete Grade XII standing or equivalent, or

Higher National Certificate (without endorsements), or

Engineering Technician (Grade 2) qualifications plus further evening school or part-time instruction to the level of the two year Technical Institute Course referred to above, and

(b) *Practical Experience*

Three years' experience (one of which shall be in Canada) for holders of the Higher National Certificate (without endorsements)

Three years' experience for applicants who have completed one year of an engineering course in a recognized university or a two year Technical Institute course

Three years' further experience for persons who previously had been classified as an Engineering Technician (Grade 2).

IV. *Engineering Technician (Grade 4)*

(a) Minimum educational requirement:

Completion of the first two years of an engineering course in a recognized university, or

Diploma from the Ryerson Institute of Technology, or

Other Institutions with an equivalent standing, or

Higher National Certificate with satisfactory endorsements, or

Examination established by the Certification Board.

(b) *Practical Experience*

Three years' further experience for applicants who have completed the first two years of an engineering course in a recognized university, or for holders of the Ryerson Diploma (or equivalent)

Two years' experience (one of which shall be in Canada) for applicants who hold a Higher National Certificate (with endorsements)

Two years further experience for persons who had previously been classified as an Engineering Technician (Grade 3)

V. *Engineering Technician (Grade 5)*

(a) Minimum educational requirement

Intermediate examinations of the Association of Professional Engineers of Ontario, or

Completion of examinations prescribed by the Certification Board.

(b) *Practical Experience*

Two years' further experience beyond Grade 4, or equivalent.

NOTE: Experience in all grades must be of a type that is satisfactory to the Certification Board.

Engineers in the News

Geoffrey T. Gambling is now residing in Toronto and is employed by the Hydro-Electric Power Commission of Ontario as plant engineer in the fuel electric generation department.

Peter Munk has recently formed Peter Munk Associates Ltd., 781 Warden Ave., Toronto, for the purpose of designing audio-electronic installations for industry and the home.

Mr. Munk was earlier associated with Atlas Radio Corporation Ltd., Toronto.

J. T. Dew has been appointed general manager of Kilborn Engineering (1954) Ltd., Toronto. This was recently announced by R. K. Kilborn, president of the Company.

Mr. Dew graduated in mechanical engineering from the University of Toronto in 1949 and has been with the organization for the past seven years.

J. Owen Dibbs of Toronto is vice-president of Executive Services Limited, management consultants, of 200 Bay Street, Toronto, Ont.

J. G. Beresford is assistant manager of the project engineering department of Union Carbide Canada Limited, 2221 Yonge Street, Toronto 7, Ont.

John B. Moore is partner in the firm of Dawes-Moore-Associates, Architects and Engineers, 216 Queen Street, Chatham, Ont. The firm name was changed at the beginning of the year from Dunlop-Moore-Associates.

Mervyn C. Jerrard has moved to Minneapolis, Minn., where he is employed in the engineering test department of Minneapolis-Honeywell Regulator Company in that city.

L. C. Ruby is manager of Weymouth Industries Ltd., Weymouth, N.S.

D. S. McCann who was recently appointed assistant general sales manager of Peacock Bros. Limited, continues as manager of the Company's Toronto office.

Donald F. Martin general sales manager of Packard Electric Co. Ltd., has been elected as a vice-president and a director of the company. **W. L. Hetherington** has also been elected a vice-president of the company.

Mr. Martin fills the vacancy created by the resignation of C. W. Spratt who has been with the company for 46 years.

Herbert A. Skelton has been appointed to the staff of the Canadian development and research division of the International Nickel Company of Canada, Ltd., Toronto. He will be directly concerned with the mechanical and metallurgical problems in welding, fabrication and general manufacturing fields.

Mr. Skelton graduated in metallurgical engineering from Toronto in 1940 and following graduation joined the John Inglis Company in Toronto as assistant chief metallurgist. From 1943 until the end of World War II he served with the Royal Canadian Navy as an engineer officer.

Following the war he was appointed chief metallurgist of the consumers product division of John Inglis Company succeeding to the position of chief metallurgist of all divisions in 1948. He held this position until joining the International Nickel Company.

NOVA SCOTIA

1957 Council Announced

Elected president of the Association of Professional Engineers of Nova Scotia is E. D. Brown, vice-president and general manager, National Gypsum, Canada Limited, Burnside, Dartmouth, replacing C. N. Murray, general superintendent of the Dominion Iron and Steel Ltd., Sydney. L. D. Wickwire was chosen to fill the office of vice-president.

In the election of councillors the following were named for a one year term: L. J. Archibald, mechanical superintendent of the Halifax Refinery, Imperial Oil Ltd., Dartmouth; A. A. Ferguson, president of the Pictou Foundry and Machine Company at Pictou; W. D. Hagen, manager, Robb Engineering Works Limited, Amherst; G. F. Vail, associate professor of electrical engineering, Nova Scotia Technical College, Halifax.

Councillors for a two year term of office are; B. N. Cain, dean of applied science are; B. N. Cain, dean of applied science, Acadia University, Wolfville; J. D. Kline, assistant manager and chief engineer, Public Service Commission Halifax; A. B. Rossetti, president and general manager, Sydney Engineering and Dry Dock Company Ltd., Sydney and J. B. Ternan, registrar of the Nova Scotia Technical College, Halifax.

Secretary-treasurer and registrar of the organization is E. Lee Cameron, assoiate professor of mineral engineering, Nova Scotia Technical College.

On the Standing Committees, E. D. Brown, of Halifax, L. D. Wickwire, Liverpool, C. N. Murray, Sydney, L. J. Archibald, Dartmouth, and J. D. Kline, of Halifax, were elected to the executive Committee.

On the Board of Examiners are: G. F. Vail, chairman, of Halifax; G. F. Bennett; G. H. Burchill; M. F. Dean; W. A. Devereaux; J. B. Ternan; and D. E. Whitman, all of Halifax.

Comprising the Professional Relations Committee are F. C. Morrison, chairman, of New Glasgow; A. E. Cameron, vice-chairman, of Halifax; W. A. Macdonald of Sydney; E. T. Cosgrove of Halifax; and J. J. Kinley of Lunenburg.

On the nominating committee are E. D. Brown of Halifax, chairman; C. N. Murray, Sydney; M. L. Baker, J. L. Wickwire, and E. L. Cameron, all of Halifax.

G. L. Renner, J. E. Reardon, and E. R. Richard of Halifax will form the Scrutineers Committee. Mr. Renner was elected chairman.

Representatives for 1957

C. N. Murray of Sydney will serve as representative on the Dominion Council. E. D. Brown and E. Lee Cameron of Halifax have been chosen as Observers.

Representative on the E.I.C. General Council is Professor M. L. Baker, Halifax; while L. J. Archibald, Dartmouth and Dr. B. N. Cain of Wolfville will carry out these duties on the A.P.E.N.S. and I.E.C. Joint Finance Committee.

BRITISH COLUMBIA

Engineers in the News

D. A. Whelan has become a partner in the firm of Associated Engineering Services Limited. The firm now offers a broad service in general municipal engineering.

Mr. Whelan has spent more than ten years in the municipal engineering field and during the past six years has been municipal engineer for the District of Burnaby.

R. L. Walker is leaving his position as executive assistant, Fraser River Board, to take up a post with Photographic Surveys Corporation and will be stationed in Ceylon.

E. M. Silver has moved from his position at Grant's Brewery Limited, Winnipeg, to Western Canada Breweries Limited, Vancouver.

A. J. Routley of New Zealand has joined the staff of Crippen Wright Engineering Limited.

F. W. Clark has joined Imperial Oil (Alberta) Limited in an engineering position at Calgary.

A. T. Vaughan, recently arrived from the United Kingdom via Ontario, has joined the firm of Jones, Read and Christoffersen.

Allan Drab, a 1956 U.B.C. graduate has also joined this firm.

J. L. R. Hughes has taken up an appointment with Wiesser Lock Company of Canada Limited.

H. P. Burden is now a flying officer, engineering division, R.C.A.F., Cold Lake, Alta. Mr. Burden was for three years with his father, F. P. Burden, surveyor and civil engineer at Prince George.

J. R. M. Palmer, who recently arrived from the United Kingdom has joined the Powell River Pulp and Paper Company at Powell River.

J. S. C. Frost is now a design engineer with the P.G.E. Railway. He was formerly divisional engineer at Squamish.

J. Guthrie has been appointed to the position of manager, Columbia Cellulose Company Limited. He was formerly at Port Alice, B.C.

R. C. B. Henderson is with the International Engineering Company Inc., and is working on a dam and spillway project in Kaptai, East Pakistan.

ALBERTA

Abstracted from the Alberta Professional Engineer, January, 1957

It is interesting to reflect upon what may take place in the next eighteen years and also to ask, what will be the nature of engineering at the third quarter century mark?

During the second quarter of the twentieth century there were many changes. This was the period of engineering's great contribution to making man's labor more effective. The use of powered machines made it possible for each worker, in 1950, to produce twice as much as he did in 1925.

In this same period there were changes in engineering. This quarter century saw the development of many new specialized engineers; the aeronautical, petroleum, electronics, the reservoir, sanitary, industrial and many other types of engineer, as well as geophysicists, nuclear physcists, and petro-chemists.

Multiplying Manpower — Brainpower. As we approached the beginning of the third quarter the engineer and the scientist had turned their efforts to developing tools to make their work easier. In the second quarter the emphasis had been on multiplying manpower. Some of the emphasis has now shifted to multiplying brainpower. The engineer now finds it is not necessary to engage in days and months of brain-breaking mathematical calculations; he can now call upon an electronic machine to do this tedious work for him.

Aided by these and other machines in his search for new ideas, methods and machines, he will, before 1975 have found hundreds of new materials. This demand for new materials arises through the need to conserve present material resources and through the necessity to develop materials to meet new requirements of strength, corrosion and temperature resistance, chemical and electrical properties. The last ten years has seen the new names: epoxies, acrylics, polyethylene, polyesters and many others.

Conservation a Factor. The need for the conservation of materials and manpower will see its effect in the design of machines and structures. The development of lighter and stronger materials will help. In the steel industry pilot continuous casting plants are now in use. Full-scale units will eliminate the use of much massive equipment and manpower. In buildings the search will be for lighter, lower material content structures, smaller air conditioning and electrical distribution systems and new all-purpose materials. In product design the engineer will search for ways of reducing material and labor content.

One of the major problems facing engineers today and a problem that will become more difficult is that of waste disposal. In the second quarter of the century progress was made in the effective use of wastes in many industries. By 1975 great strides will have been made, possibly to the extent that atomic reactor wastes will then be useful by-products.

To run the ever increasing number of machines will require the development of more sources of power. The development of new fuels, new power sources, and the more efficient use of present power supplies will challenge the engineer. The use of solar, tidal and other potential sources of large quantities of power will be studied. New fuels to power air-borne transport will be developed. Above all the engineer will be called upon to use available power more efficiently.

Co-ordination. The engineer will find, too, in the next eighteen years, that he must search for a better understanding of men. In research, design, production and practically all aspects of engineering he will depend to a greater extent upon the work of others.

The use of technicians to assist the engineer directly and the demand for engineering experience in management, sales, and other aspects of business requires a greater knowledge of human behavior. This will lead to his study of more of the basic sciences, especially of psychology and physiology. He will apply statistical and scientific methods to the study of man, his motivations, his habits and his welfare.

To accomplish the great advances which will be his opportunity will require ascending standards of professional responsibility and technical ability. Just as he must improve his use of men and materials so must he strive for self-improvement. The engineer will not fail in his responsibility in what may well be known as the Engineering Age.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

James Shearer Costigan, M.E.I.C., president of T. Pringle and Son Limited, industrial engineers of Montreal, died at his home at Westmount, Que., on February 11, 1957.

A native of Montreal, Mr. Costigan was born on September 21, 1873. His engineering studies undertaken at McGill University, he graduated with a B.A.Sc. degree in mechanical engineering in 1894. He gained his early experience with the Dauville Asbestos and Slate Company as assistant superintendent of an asbestos fibrizing mill and with the Glasgow and Montreal Asbestos Company as manager of the Black Lakes Mines.

Mr. Costigan became associated with the firm of T. Pringle and Son, as a mechanical engineer on the original Shawinigan Water and Power Company development at Shawinigan Falls in 1898. In 1902 he gained the appointment of chief engineer in charge of the design of water and steam plants and many other industrial works. On the incorporation of the company in 1907 he was elected vice-president of the firm and assumed charge of the general management of the business of the company. In 1928 Mr. Costigan became president of the firm in which he remained active until his eightieth year.

He joined the Institute as a Student member in 1889, and transferred to Member in 1908. He attained Life membership in 1947.

Major A. R. Ketterson, M.E.I.C., former engineer of bridges for the Canadian Pacific Railways, died in Montreal on February 11, 1957.

Major Ketterson was born in Scotland on June 24, 1881, at Greenock. He attended public and private schools in Scotland and later became a student of the Royal Technical College, Glasgow. He graduated in 1902 with the degree of Associate of the Royal Technical College, later carrying out post-graduate work in advanced structures at that College. He also served with the Argyll and Sutherland Highlanders for three years during an early period of his career and held various appointments in Scotland before moving to Canada. These included the firm of A. Findlay and Company Limited, bridge builders, at Motherwell, Scotland, and Babtie and Brown, consulting engineers at Glasgow.

First employed as a bridge builder with the Canadian Pacific Railway in 1907 he was also employed as a draughtsman and became an assistant engineer at Winnipeg. In World War I he served with the First Canadian Construction Battalion and became second in command of the battalion. He was retired from the army with the rank of major and was awarded the D.S.O.

In 1928 appointed assistant engineer of bridges, he was in 1937 named engineer of bridges at Montreal and continued to hold the post until his retirement in 1946.

Major Ketterson joined the Institute in 1908 as an Associate Member. He was transferred to Member in 1938 and attained Life Membership in 1947.

William Norman McGuiness, M.E.I.C., of the Northern Electric Company, Montreal, died at Ciudad Trujillo, in the Dominican Republic on August 28, 1956, while on holiday.

W. N. McGuiness, M.E.I.C.

Born at Montreal on October 2, 1896, Mr. McGuiness had his schooling in Montreal. He enrolled at the Montreal Technical School graduating in 1915.

Beginning his career with Northern Electric at that time he worked first as a maintenance electrician and a telephone equipment draftsman. During World War I he served with the Fifth Canadian Division Column in Europe. On his return to Canada in 1919 he was appointed supervisor of the power equipment department of the firm. In 1920 he was transferred to the duties of power equipment engineer.

Mr. McGuiness served in various capacities with the equipment engineering department until early in the Second World War when he was loaned to the Crown company named Communications Limited. He was assigned the duties of power equipment engineer to assist in the design of power equipment for an East Coast carrier system. On his return to the company he was transferred to the dial equipment engineering division of the firm and was in 1948 named assistant superintendent of instal-lation engineering.

On loan to the Bell Telephone Com pany of Canada, special contract de partment in 1955, he supervised the en gineering of power equipment for al doppler stations on the Mid-Canad Line.

He joined the Institute in 1929 as a Associate Member, and transferred t Member in 1940.

Harry E. McCrudden, M.E.I.C., forme Bell Telephone official, at Montrea died there on December 24, 1956.

Mr. McCrudden was born in Buenc Aires in 1892. He had his early schoo ing at Montreal and attended McGi University. Interrupted in his studies b World War I, he enlisted in the Can dian Field Artillery, serving in Englan France and Belgium with the 43rd Arti lery Battery. On his return to Canad he worked with the Department of So dier's Civil Re-Establishment at Mon real until 1923 when he first becam associated with the Bell Telephone Con pany of Canada, working as a metho clerk with the firm. In 1927 employe as a plant inventory and cost engine with the engineering department of tl Company, he was in 1930 promoted staff engineer. Mr. McCrudden devot his entire career to the Bell Telephor Company of Canada and retired 1952, after thirty years' service.

During World War II, he was grant leave of absence in order to serve wi the Canadian Air Ministry in Ottawa.

He joined the Institute as a Stude Member in 1913, was transferred Junior in 1919. He became an Associa Member in 1927 and a Member in 194

Carlo Antonio Carniel, M.E.I.C., pre dent of the contracting firm of C. Carniel Limited, Ste. Therese, Qu died there on January 4, 1957.

Born at Vedelago, Italy on Septemb 24, 1885, he was educated at Veni and came to Canada early in the centu

Throughout his engineering career e ployed in the fields of railroad, wh construction and highway building, was in 1906 engaged as engineer a superintendent for the firm of Cavic and Pagano on the National Transco tinental Railway. In 1910 he worked the construction of the Algoma Cent Railway. Superintendent of the Bedfo Construction Company during the cle ing of the Halifax disaster of 1917 worked with that firm on the buildi of the Halifax Shipyard in 1918, a held the post of manager of constr tion in the erection of the St. John D Dock and shipyard. Engaged in ma large projects, he has been in rec times employed in the building of hi ways for the province of Quebec.

Mr. Carniel joined the Institute as Associate member in 1920, transferr to Member in 1940. He attained t status of Life member in 1955.

Personals

News of the Personal Activities of Members of the Institute

J. T. Dyment, M.E.I.C., director of engineering for Trans-Canada Air Lines, has been named chairman of a new Turbines Operations Panel of the International Air Transport Association. The panel will consist of seven experts of Canadian, American, British, Dutch and French airlines. It will co-ordinate the joint effort of the world's airlines to develop the most efficient flight procedures and requirements for the new age of jet and turbojet aircraft. Mr. Dyment was chairman of the I.A.T.A. Jet Symposium in 1950 and has since headed its jet fuel study.

Dean R. E. Jamieson, M.E.I.C., dean of the faculty of engineering at McGill University will retire from this position on June 1, 1957.

He will then become director of planning for the Brace bequest. Totalling $2,000,000, the bequest provides for the founding of a practical method of providing water in economic quantities for parched areas of the globe.

Dean Jamieson has had a very long history with the University. He began his studies there, gaining a B.Sc. degree in 1914 and an M.Sc. degree in 1920. Around this period he served overseas with the Army in World War I and had experience on railway location, construction work and structural design before commencing his teaching career at McGill in 1920. A lecturer in mathematics and civil engineering in the first years, he became a full professor and chairman of the department in 1932. His appointment as dean of the faculty dates to 1952.

Dean R. E. Jamieson, M.E.I.C

During the Second World War Dean Jamieson served as director general of the Army Engineering Design Branch of the Department of Munitions and Supply in Ottawa. After his resignation from this position in 1945 he remained a member of the Army technical development board, and was at that time awarded the O.B.E.

President of the Canadian Standards Association in 1953 he had previously served as vice-chairman of the executive committee of the organization.

Dean Jamieson was president of the Corporation of Professional Engineers of Quebec in 1939. He has served on many committees of the E.I.C. and was in 1952 elected to fill the office of treasurer of the Institute.

Professor Donald Mordell, M.E.I.C., will take over the appointment of dean of the faculty of engineering at McGill University on June 1, 1957, following the retirement of Dean R. E. Jamieson.

Professor Mordell followed his engineering studies in England, the country of his birth. He attended Cambridge University and was granted a B.A. in mechanical sciences in 1942. Four years later he was awarded an M.A. in mechanical sciences. During the war years he was also associated with Rolls Royce Limited, England. He became engineer in charge of combustion research and development and worked on gas turbine development.

Coming to Canada shortly afterwards he accepted the post of associate professor of mechanical engineering at McGill University in 1947. Promoted to full professorship in 1955 he was also made chairman of the department at that time.

Professor D. Mordell, M.E.I.C.

R. F. Leggett, M.E.I.C.

As well as his usual duties, he has recently served as director of research in the Gas Dynamics Laboratory at Ste. Anne de Bellevue, Que. Work has been proceeding there under grants from the Department of Mines and other Federal agencies on the development of a coal-burning gas turbine.

Professor Mordell is an associate member of the Institution of Mechanical Engineers and the Royal Aeronautical Society.

Kenneth I. Shone, M.E.I.C., holds the appointment of visiting professor of industrial administration for the Carnegie Institute of Technology, graduate school of industrial administration, at Pittsburgh, Pa.

Professor Shone was in 1948 an assistant professor of mechanical engineering at McGill University. In 1952-53 he was sent on loan from the Royal Technical College, where he held his next appointment, on a mission to India with the International Labour Office.

Lately he has been in charge of the residential centre for management studies with the Royal Technical College.

Professor Shone is a graduate of Cambridge University.

R. F. Legget, M.E.I.C., director of the Division of Building Research of the National Research Council of Canada was

• PERSONALS

admitted to honourary membership in the Ontario Association of Architects at the annual meeting of that organization held recently in Toronto.

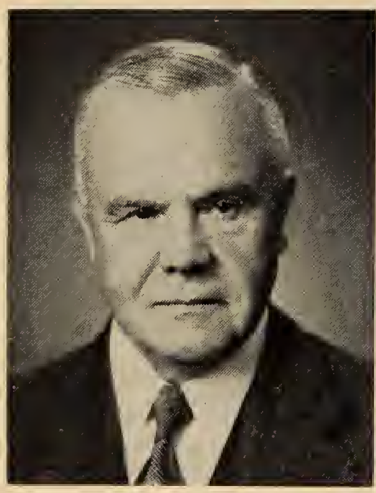
Mr. Legget was elected an Honourary Fellow of the Royal Architectural Institute of Canada in 1953. He is also a Fellow and Councillor of the Geological Society of America, a Member of the Institution of Civil Engineers and the American Society of Civil Engineers.

Mr. Legget was in 1947 invited by the National Research Council to start the new Division of Building Research and has been director since that time.

Mr. Legget was previously employed as an associate professor and consultant on soil and foundation problems at the University of Toronto.

Mr. Legget is a past-chairman of the Toronto and Ottawa Branches of the Institute. He is also serving on the Council representing the Ottawa Branch during the current season, 1956-57.

J. B. Woodyatt, M.E.I.C., has been appointed to the board of directors of the Shawinigan Water and Power Company. Chairman of the board of Southern Canada Power Company and Power Corporation of Canada, he is also a director of Bathurst Power and Paper Company Limited, the British Columbia Power Corporation and other companies.



J. B. Woodyatt, M.E.I.C.

W. R. Way, M.E.I.C.

Mr. Woodyatt became president of the Southern Canada Power Company in 1926.

W. R. Way, M.E.I.C., has been appointed to the board of directors of the Shawinigan Water and Power Company. Mr. Way is vice-president and chief engineer of the Shawinigan Water and Power Company and a director of the St. Maurice Power Corporation and the Shawinigan Engineering Company, Limited.

Mr. Way has been with the Shawinigan Water and Power Company for over thirty-eight years.

David S. Lloyd, M.E.I.C., of Toronto has been appointed a vice-president and director of Pyrofax Gas Limited, Toronto, a subsidiary of Pyrofax Gas Corporation, a unit of Union Carbide and Carbon Corporation.

Mr. Lloyd is president of the Linde Air Products Company, division of Union Carbide Canada Limted. First associated with the Pyrofax Corporation twenty-five years ago in the introduction of propane gas in cylinders into Canada, he was in 1939 concerned in the building of the original Montreal Pyrofax plant, first plant in Eastern Canada where propane was filled into cylinders for general distribution. His experience in the compressed gas business dates to 1925 when he joined the staff of Dominion Oxygen Company Limited, forerunner of the present Linde Air Products Company as a service engineer.

Mr. Lloyd received the degree of bachelor of applied science in electrical engineering from the University of Toronto in 1925. Prior to joining the Union Carbide organization he worked for Algoma Steel Corporation Limited, the Great Lakes Power Company Limited, the Department of Northern Development of the Province of Ontario and the Robert D. Hunt Company Limited.

D. D. Morris, M.E.I.C.

D. S. Lloyd, M.E.I.C.

He was a member of the administrative board of the Canadian Welding Bureau at its inception and is a past-chairman of this administrative board. He is a past-director of the Canadian Standards Association.

D. D. Morris, M.E.I.C., formerly administrative assistant with the Consolidated Mining and Smelting Company Limited has been named assistant general manager of the company.

He has served in numerous capacities in Cominco's chemical fertilizer and research divisions. He was appointed manager of the research and development division in 1951, administrative assistant in 1954 and assistant to the general manager in 1955.

First associated with the company in 1928, he began his work in the fertilizer research field in the mid-thirties and in 1940 was named assistant general foreman of ammonia operations at Trail, B.C. During the second World War, Mr. Morris served as superintendent of the government's ammonia plant at Calgary, becoming in 1943 general superintendent of operations in that area. Named head of the Cominco research and development division in 1949 he was transferred to Trail at that time.

Born at Edmonton Mr. Morris graduated from the University of Alberta in 1928.

He is a fellow of the Chemical Institute of Canada.

Dean E. O. Turner, M.E.I.C., of the faculty of engineering and professor of civil engineering at the University of New Brunswick will retire at the end of the current academic year.

Born at Harvard, Mass., he studied engineering at the Massachusetts Institute of Technology and graduated in civil engineering in 1914. He served with the

• PERSONALS

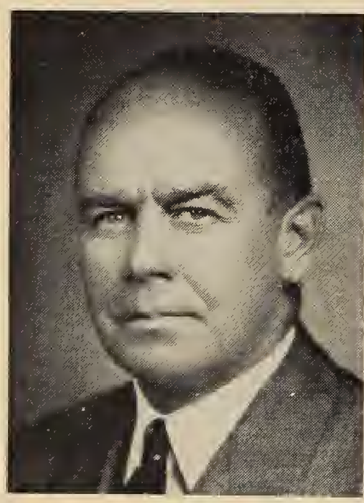
United States Army Air Force for two years and then had experience with the Boston and Maine Railway, the Massachusetts Highway Commission and the Polytechnic Institute of Brooklyn as an instructor before accepting the appointment which was to become his life work. Named professor of engineering and department head at the University in 1919 he carried out these duties until his promotion to deanship in 1946.

In 1941 the University awarded him the honorary degree of Doctor of Science.

Among the scientific societies in which Dean Turner has membership are the American Society for Engineering Education and the North American Branch of the Newcomen Society of England.

Vice-president of the Institute representing the Maritime provinces for the 1950-51 term, he has also served as one of its active supporters in the position of councillor.

D. O. Turnbull, M.E.I.C., consulting engineer of Saint John, N.B. has extended his firm in order to form a partnership with J. W. G. Scott, M.E.I.C. The practice will be carried on under the new name of Turnbull and Scott Limited.



D. O. Turnbull, M.E.I.C.

J. W. G. Scott, M.E.I.C.

A graduate of the University of New Brunswick in civil engineering, class of 1949, Mr. Scott began his career with the Department of Public Works (Canada), and has since 1952 been associated with Mr. Turnbull. He is a past-secretary of the Saint John Branch of the Institute.

Mr. Turnbull has been in private practice in Saint John since 1945. His early years in the profession were spent with the Foundation Company of Canada.

Active in the affairs of the Institute Mr. Turnbull is a past-chairman of the Saint John Branch, 1950, and was the following year elected to the Council of the Institute. He is also a past-president of the Association of Professional Engineers of New Brunswick.

V. C. Hamilton, M.E.I.C., general manager of operations with the Canada Cement Company Limited has been named a director in the organization.

Formerly general superintendent of the company, he has had many years' experience in the cement industry and was first employed with Canada Cement in 1927. At that time he was engaged in construction work for the firm at Lakefield, Ont. During the next few years he became plant superintendent for the firm at Exshaw, Alta., and at Winnipeg, Man.

He is a graduate of the Royal Military College, and a veteran of six years overseas service in World War II.

V. K. Mason, M.E.I.C., has been appointed vice-president of Perini Limited, formerly known as B. Perini and Sons Canada Limited.

Chief engineer in 1954, Mr. Mason has been associated with the organization for a number of years. A 1942 graduate from McGill University with a B. Eng. degree in civil engineering, he spent the following three years of World War II with the Royal Canadian Naval Volunteer Reserve at Halifax and Esquimalt, B.C. Later he worked with Ward McKee Engineering, and Hardy Limited, construction division, at Toronto.

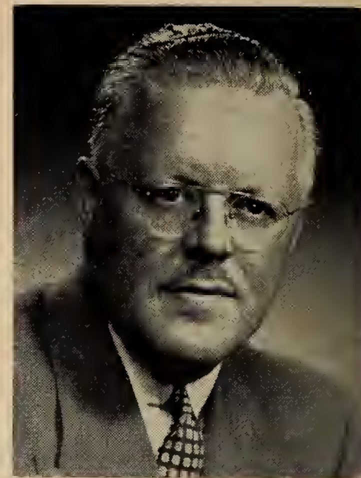
F. S. Maconachie, M.E.I.C., has been appointed chief engineer and is in charge of Canadian operations of Coode, Binnie and Preece, consulting civil, electrical and mechanical engineers.

Mr. Maconachie has established an office for the firm in Ottawa and is located in the Roxborough Apartments, on Laurier Avenue.

One of the Canadian organization's consultants is **Dr. P. L. Pratley,** M.E.I.C.

K. W. Fraser, M.E.I.C., has been appointed manager of the Canadian Westinghouse Company, Pacific district, with headquarters at Vancouver. He will be directly responsible for all sales of Westinghouse apparatus products throughout the Pacific district.

Mr. Fraser was formerly with the firm



K. W. Fraser, M.E.I.C.

F. S. Maconachie, M.E.I.C.

of B. F. Sturtevant Company of Canada Limited, and was general manager of the subsidiary since 1951. He previously held important posts in sales in Montreal and at Hamilton headquarters.

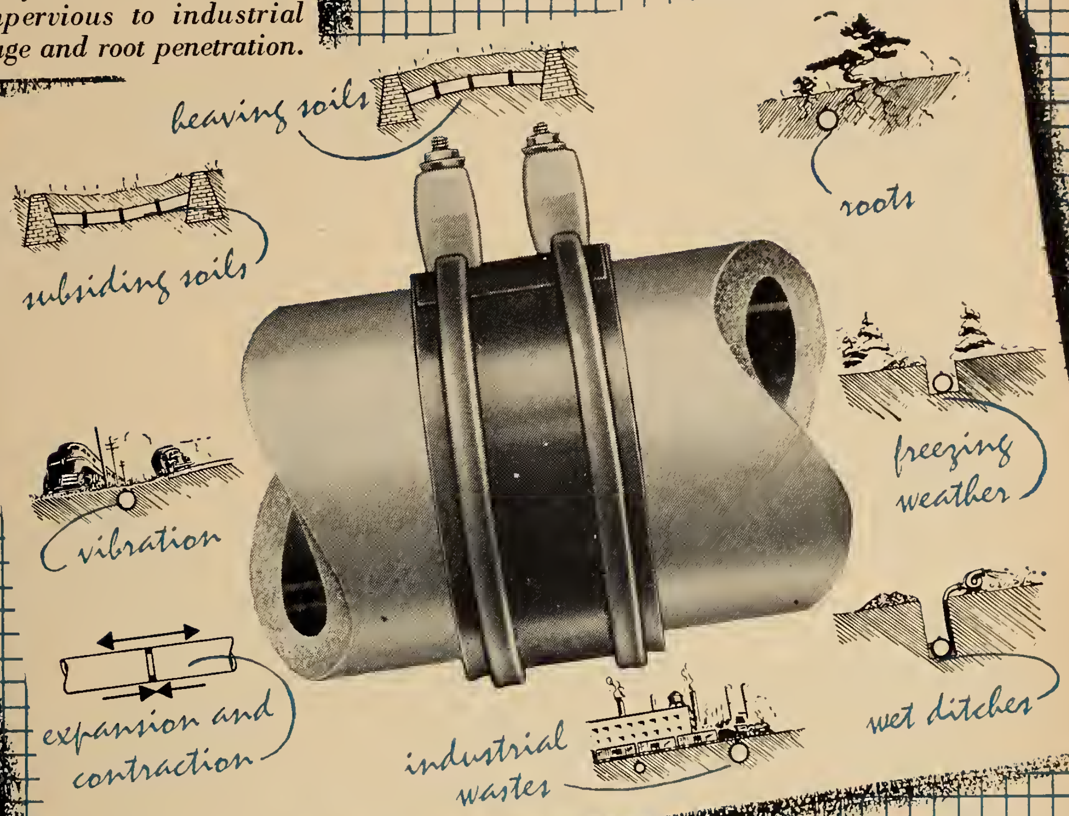
Mr. Fraser assumed the duties of sales engineer with the firm in 1930 and was appointed Quebec district manager shortly afterwards. During the following twelve years he was closely linked with the Westinghouse participation in many industrial and utility developments throughout the province of Quebec, particularly in the aluminum and pulp and paper industries.

Lieut.-Col. M. Barry Watson, M.E.I.C., professional engineer and land surveyor has been appointed Suburban Roads Commissioner for the City of Niagara Falls, Ont. He has also been elected chairman of the Public Library Board in that city.

Long established in the field of consulting engineering Lieut. Col. Watson is a graduate of the University of Toronto and a veteran of World War I. He was for many years a resident of Toronto and along with his private practice carried out the duties of director of the department of Military Studies at the University of Toronto.

Problem

National Sewer Pipe Limited needed a flexible sewer coupling that could be laid in any kind of weather and remain impervious to industrial waste seepage and root penetration.



Solution

They chose Polysar Butyl 301. This special type of Polysar has high resistance to ozone, water, heat and cold—remains constantly flexible—and gives a pressure-tight fit unaffected by either sewage or soil attack.

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SARNIA CANADA

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The example stated here is just one instance of how Polysar rubbers and Polymer's research chemists write new uses for rubber into the diary of synthetic rubber. In countless industries Polysar synthetic rubber is making better rubber products.

If you have a technical problem it may well be that Polysar synthetic rubber holds the best answer. Write to our Sales and Technical Service Division, Polymer Corporation Limited, Sarnia, Canada.

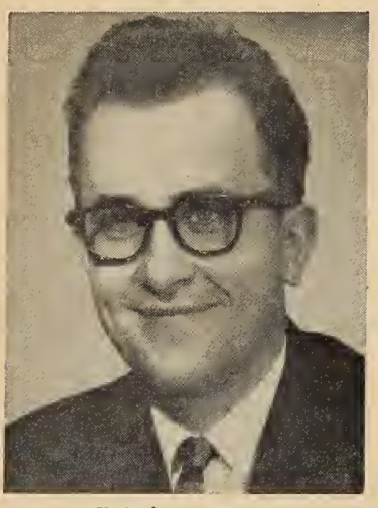
POLYMER CORPORATION LIMITED
SARNIA • CANADA

NOTHING PERFORMS LIKE RUBBER — *The best buy for your money*

• PERSONALS

He also served as registrar of the Association of Professional Engineers of Ontario earlier in his career and is as well a past member of the executive of the Toronto Branch of the Institute.

Zane Bakun, M.E.I.C., has been appointed director of community planning with the Department of Municipal Affairs of the Province of Saskatchewan.



Z. Bakun, M.E.I.C.

Mr. Bakun received a Bachelor of Science degree in civil engineering from the University of Manitoba in 1952. On receiving a Central Mortgage and Housing Fellowship in community planning, he completed post-graduate studies at the University of Manitoba and in 1953 gained an M.Sc. degree in that field.

Upon graduation employed by the Community Planning Branch of the Saskatchewan Department of Municipal Affairs as a community planning adviser he held this position until his present appointment.

J. T. Dokken, M.E.I.C., has joined the Inland Cement Company Limited of Edmonton, Alta, as district sales engineer for the Province of Saskatchewan with headquarters at Saskatoon.

A graduate of the University of Saskatchewan in civil engineering Mr. Dokken has had previous engineering experience with P.F.R.A., at Regina.

A. E. Stewart, M.E.I.C., for many years associated with the Canadian Pacific Railway in British Columbia has retired and is living in Vancouver. Mr. Stewart was divisional engineer at Revelstoke B.C., at the time of his retirement.

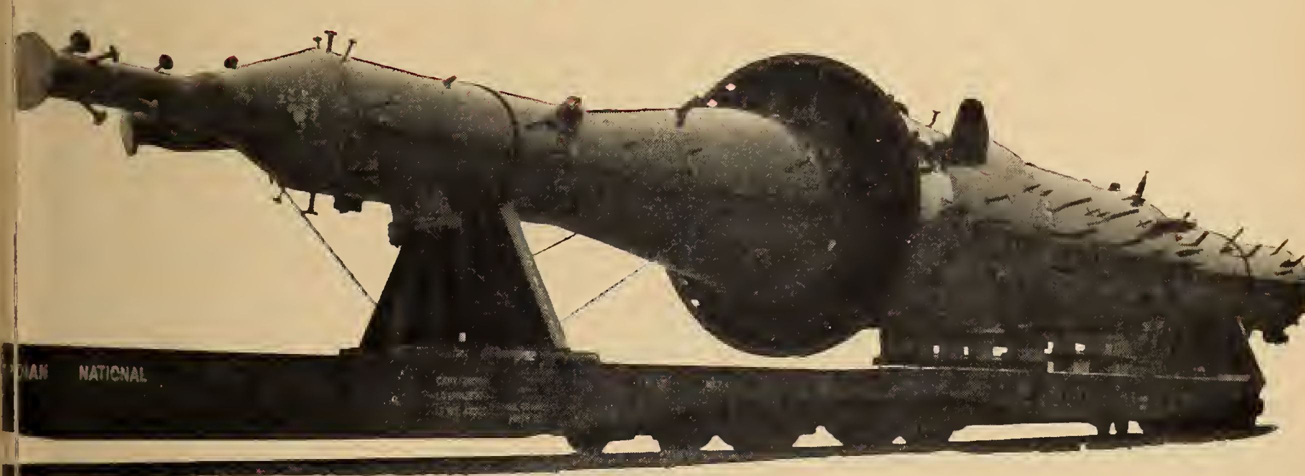
His engineering career with the Railway dating to 1909, he graduated from the University of Saskatchewan in civil engineering in 1922, after several years overseas service in World War I. With the Canadian Engineers in France, and the Royal Engineers in India, he also took part in the Third Afghan War at Baluehistan in 1919.

Assistant to the divisional engineer at Glacier, B.C. in 1922 he also held appointments at Lethbridge and Bassano, Alta. during the nineteen twenties. In 1931 he became division engineer of terminals at Winnipeg, Man., and the following year was posted to Regina, Sask. Later, in 1939 he was located at Cranbrook, B.C.

T. H. Dobbin, M.E.I.C., commissioner of works for the City of Sarnia, Ont, since 1952, has been named to a senior engineering post with the City of Ottawa. His duties are those of engineer in charge of design and special projects with the department of planning and works.

Mr. Dobbin is a 1949 graduate of the University of New Brunswick in civil engineering who undertook professional engineering studies after a number of years previous experience in building construction and land surveying and a six years period with the Royal Canadian Engineers in World War II.

WHAT IN THE WORLD IS IT?



It weighs 78,000 lbs. and it took three flat cars to ship it. You might think it was a tough job but we've specialized in steel plate fabrication for fifty years so just took it in our stride. You are wrong if you thought it was an atomic weapon. It's a Reactor Scrubber used in the refining of oil.

Specialization in the design, fabrication and erection of steel plate, stainless steel, Monel, nickel, aluminum and alloys have brought us, an all-Canadian company, leadership in this field. Send us your blueprints or problems for designs or quotations.

50th ANNIVERSARY
T.I.W. STEEL PLATE PRODUCTS
1907 – 1957

THE
TORONTO IRON WORKS
LIMITED
TORONTO-MONTREAL
IN WESTERN CANADA-T.I.W. WESTERN LIMITED, EDMONTON, ALTA.
DESIGNERS • FABRICATORS • ERECTORS

• PERSONALS

Since then he has held appointments with the City of Fredericton, N.S., the City of Saint John, N.B., as assistant director of works, and with the H. G. Acres Company at Niagara Falls, and Pine Falls, Ont.

In 1956 Mr. Dobbin was elected secretary-treasurer of the Sarnia Branch of the Institute.

J. A. Clement, M.E.I.C., of Montreal has recently been named superintendent of bridges with the National Harbours Board at the Montreal harbour.

A 1944 graduate of Ecole Polytechnique he has spent a number of years with Victoriaville Furniture Limited, Victoriaville, Que., and served as director of production control.

Earlier in his career he was an industrial engineer for the British Rubber Company of Canada Ltd., Lachine, Que.

Russell E. Potter, M.E.I.C., of Victoria, B.C., has gone into private practice in that city, specializing in the fields of municipal engineering, public utility regulation and hydro-power. He formerly held the appointment of Public Utilities Commissioner at Victoria.

Mr. Potter has, for the last fifteen years been employed as chief engineer of the City of New Westminster, B.C., and as executive assistant to the Dominion-Provincial Board, Fraser River Basin, at Victoria before embarking on his duties as Public Utilities Commissioner.

He is a graduate of the University of Saskatchewan in civil engineering.

A. K. Bunnell, M.E.I.C., formerly assistant to the vice-president, engineering department for Canadian Breweries Limited, Toronto has become superintendent, mechanical engineering department with Carling Breweries Limited, also of Toronto.

Mr. Bunnell graduated from the University of Toronto in mechanical engineering in 1947 and joined Canadian Breweries, working as an assistant superintendent of mechanical engineering.

A. H. Ashworth, M.E.I.C., consulting engineer of North Vancouver has formed his practice into the limited company of A. H. Ashworth and Associates Limited, with the inclusion of J. E. Dew-Jones, A.M.I.C.E., as an engineering director.

Like Mr. Ashworth, Mr. Dew-Jones, came to this country from Great Britain. He has since 1954, worked in the engineering department of the District of North Vancouver, with John Laing and Son (Canada) Limited, and with the Annacis Island Industrial Estate.

Mr. Ashworth assumed the duties of municipal engineer for the North Vancouver district in 1952 and was concerned in the water works modernization and expansion program on the North Shore linking up with Vancouver's new Cleveland Dam in Capilano Canyon.

In 1954 he took part as a member of the special committee set up by surrounding municipalities in the preparation of a report on Burrard Inlet Crossings to consider future bridges and other facilities to cross Vancouver Harbour.

Mr. Ashworth has had experience in civil engineering projects in Great Britain, South Africa, Rhodesia, New Zealand and Canada. Several professional engineers associated with him in each location formed the group in which he became an associate, known as the North Western Associated Engineering Consultants and covering a wide field of engineering service.

C. Newton Hopkins, M.E.I.C., has moved from Shawinigan Falls, Que., to Vancouver. Formerly with Canadian Industries Limited in a supervisory capacity, he is now associated with Hook-

"CATALYTIC'S ON-TIME AND ON-BUDGET CLAIM IS NO IDLE BOAST"

ST. LAWRENCE CEMENT CO.

February 8, 1957

Mr. George E. Temple
Vice-President & General Manager
Catalytic Construction of Canada, Ltd.
600 Vidal Street South
SARNIA, Ontario

Dear Mr. Temple:

I should like to express my personal congratulations to the Catalytic organization for the vital part it played in the construction of our $28,000,000 cement plant at Clarkson, Ont.

Your traditional claim of completing contracts "On-Time and On-Budget" is certainly no idle boast. It is a fact that your work, although involved and complicated, was finished well in advance of schedule and within the prescribed budget.

This is all the more remarkable because of the fact that this was your first venture as mechanical erector of a cement plant. This speaks volumes for the ingenuity, adaptability and efficiency of the Catalytic organization.

It can truly be said that Catalytic's proven knowledge and experience excellently equips them to carry out any construction project "On-Time and On-Budget" regardless of its scope and magnitude.

Wishing you continued success, I am

Yours very truly,

ST. LAWRENCE CEMENT CO.

B. Ulrich
Executive Vice-President
and General Manager

CATALYTIC
CONSTRUCTION OF
CANADA LIMITED

[illegible] ONTARIO
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CONSULTANTS • DESIGNERS • CONSTRUCTORS SERVING THE PROCESS INDUSTRIES • PETROLEUM • CHEMICALS • PETROCHEMICALS • MINING • PULP & PAPER • TEXTILES

In U.S.A. CATALYTIC CONSTRUCTION COMPANY, Philadelphia

• PERSONALS

er Chemicals Limited as a chemical engineer.

Mr. Hopkins is a 1949 graduate of the University of British Columbia.

W. O. Horwood, M.E.I.C., has been appointed Eastern sales manager with International Equipment Company Limited and its subsidiary, Industrial Equipment Company Limited.

Mr. Horwood was named assistant to the president of International Equipment Company, at Montreal a little over a year ago.

He was earlier in his career associated with the Lyman Tube and Bearings Limited.

D. Zavitzianos, M.E.I.C., senior structural designer with the Toronto architectural firm of Shore and Moffat, has charge of the structural design of a new Federal Public building in downtown Toronto's Adelaide Street.

Mr. Zavitzianos is a graduate of the University of Athens National Technical University at Athens, class of 1948.

L. A. Bateman, M.E.I.C., formerly general superintendent in charge of power production with the Winnipeg Hydro-Electric System now holds an appointment with the Manitoba Hydro-Electric Board. He is senior engineer of the system planning department.

A native of Winnipeg Mr. Bateman joined Winnipeg Hydro in 1942.

He is a graduate of the University of Manitoba, class of 1942, and also holds an M.Sc. degree from that university.

J. M. Bennet, M.E.I.C., formerly of Calgary, Alta, has gone to Central America where he is employed with the Cuban Gulf Oil Company. In Canada Mr. Bennet was associated with the Canadian Gulf Oil Company as a civil engineer and geologist.

He is a graduate of the University of Dublin, class of 1950.

A. L. Adams, JR.E.I.C., who formerly held the appointment of resident electrical engineer with the C. D. Howe Company Limited, Atomic Energy Project at Chalk River, Ont., has moved to Sault Ste. Marie, Ont. He is now employed as an electrical maintenance engineer with the Mannesmann Tube Company Limited in that city.

He is a graduate of McGill University class of 1951.

C. A. Geddes, JR.E.I.C., has been appointed chief engineer with the firm of Bawden Industries Limited, special machinery manufacturers at Toronto.

Mr. Geddes graduated in mechanical engineering from Queen's University following service in the R.C.A.F. Before joining Bawden Industries he was associated with Canadian Westinghouse Company Limited, electronics division.

Corrosion Resistance:

Acid, alkali, and salt handling problems have been solved by Ductile Ni-Resist.

Weldability:

No difficulty in welding in shop or field.

Erosion Resistance:

The Ductile Ni-Resist series of irons show economical service under many erosive conditions; and resistance to erosion as in a pump impeller is outstanding.

Toughness:

Impact resistance of Ductile Ni-Resist is comparable to that of steel at ordinary temperatures; an important plus is that it suffers no appreciable embrittlement at sub-zero temperatures.

Castability:

Good flowing quality of Ductile Ni-Resist permits the casting of intricate designs, which are difficult to produce in some other cast corrosion-resistant metals.

Ductility:

Ductile Ni-Resist irons possess 10 to 40% elongation in a tensile test, ample for all normal service applications.

Machinability:

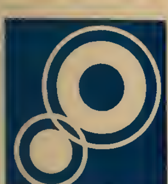
Machinability rates of Ductile Ni-Resist are of the same order as those of conventional pressure type gray iron.

Heat Resistance:

A high order of heat resistance is available with Ductile Ni-Resist up to 1300 deg. F. Certain types are recommended for service up to 1500 deg. F. Ductile Ni-Resist irons not only reduce the rate of oxidization, but also the oxidization products adhere tenaciously to the base metal.

Controlled Expansion:

Expansivities from 4.5 to 10.4 millionths per deg. F. are available with the different types of Ductile Ni-Resist.



Wear Resistance:

Metal to metal rubbing parts last much longer and perform better, especially under corrosive conditions, when made of Ductile Ni-Resist.

Non-Magnetic:

Some types of Ductile Ni-Resist irons are non-magnetic, and are therefore useful in many applications in the electric and allied fields where this quality, and the many others that this alloy has to offer, are required.

• PERSONALS

He also worked for the Brantford Engineering and Manufacturing Company at Hamilton earlier in his career.

J. E. Anderton, JR.E.I.C., a 1953 graduate of the University of British Columbia has accepted an appointment in Toronto with the hydraulic department of the John Inglis Company Limited.

In Great Britain for the past three years Mr. Anderton has been engaged in special training in the field of hydro-power with the English Electric Company.

Mervyn C. Jerrard, JR.E.I.C., has moved from Windsor to Minneapolis where he is employed with the Minneapolis-Honeywell Regulator Company in the engineering test department.

Mr. Jerrard was formerly affiliated with the Ford Motor Company of Canada Limited.

He is a University of Manitoba graduate, class of 1950 in mechanical engineering.

E. Stanley Bengston, JR.E.I.C., is employed by the Powell River Company as a design engineer in the Pulp and Paper Mill at Powell River, B.C. He was formerly employed by H. A. Simons Limited as a field engineer on the new pulp and paper mill construction at Port Alberni, B.C.

Mr. Bengston is a 1952 graduate of the University of British Columbia.

Captain R. I. Crouse, JR.E.I.C., has recently been posted to the Northwest Highway Maintenance Establishment as a roads engineer.

Awarded a B. Eng. degree in civil engineering at the Nova Scotia Technical College in 1951 he was previously posted at Montreal.

Roy A. Downing, JR.E.I.C., has been appointed chief engineer and assistant general manager with the firm of Engineered Timber Products, a division of A. S. Nicholson and Son Limited, Burlington, Ont.

R. A. Downing, JR.E.I.C.

A graduate of the University of Toronto, class of 1952, Mr. Downing has been associated with the company for several years. Earlier in his career he was employed with Timber Structures of Canada Limited, Toronto.

H. M. Curry, JR.E.I.C., a 1955 graduate of the University of Manitoba in civil engineering is employed as a field engineer at Crofton, B.C. He is engaged on the construction of a pulp plant for British Columbia Forest Products Limited.

Mr. Curry was formerly associated with the Foundation Company of Canada as a field engineer, and with the firm of H. A. Simons Limited, at Vancouver.

H. N. Dixon, JR.E.I.C., formerly of the New Brunswick Telephone Company, engineering department at Saint John, N.B., has joined the Canadian National Railways at Moncton, N.B.

In his new position Mr. Dixon is a training engineer in the motive power and car equipment department of the company.

Mr. Dixon is a 1955 graduate of the University of New Brunswick in electrical engineering.

W. L. Cary, JR.E.I.C., is associated with the research and development department of the Canadian Chemical Company Limited, Edmonton. A 1948 graduate in chemical engineering from the University of Alberta, Mr. Cary was for a number of years employed with the Aluminum Company of Canada at Arvida, Que., and also worked for the company in Jamaica, B.W.I., as a development supervisor.

M. J. M. Maughan, JR.E.I.C., a 1955 graduate of the University of Toronto in civil engineering is at work as a field engineer with the Township of Toronto at Cooksville, Ont.

He was previously employed with the Toronto firm of Marshall, Macklin and Monaghan.

Ronald W. E. McDonald, JR.E.I.C., has severed his connections with the Canadian Westinghouse Company Limited, Hamilton, Ont., and has joined the staff of the Canadian Utilities Limited at Edmonton.

Mr. McDonald graduated from the University of Alberta in 1955 in electrical engineering and enrolled in the Canadian Westinghouse Company Limited graduate training program a short time later.

Graham P. Kemp, JR.E.I.C., formerly of William Kennedy and Sons Limited, Owen Sound, Ont., has joined the staff of Dilworth Ewbank, consulting mechanical engineers of Toronto.

Mr. Kemp is a 1949 graduate of the University of Toronto in mechanical engineering and at the outset of his career was associated with the Smart-Turner Machine Company Limited at Hamilton.

NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

ORDER CITIES

J. E. DYKEMAN, JR.E.I.C.
Secretary

R. G. JOHNSON, JR.E.I.C.,
Branch News Editor

Joint Meeting

A joint meeting of the Border Cities ranch of the Institute and the local membership of the Association of Professional Engineers of Ontario was held Marios Tavern on January 17, 1957. A reception at 6.30 p.m. followed by inner at 7 p.m. preceded the general meeting. One hundred and fifteen turned it for the event.

Those at the head table were: W. G. Mitchell, past-president of the Border Cities Branch; W. R. Mitchell, councillor or the Branch; C. T. Carson, first vice-resident of the A.P.E.O.; P. N. Brown, ranch chairman; J H. Fox, president f the A.P.E.O.; J. M. Reid, Branch treasurer, and B. Goodings, field-secretary the Association.

Mr. Fox addressed the gathering, dealing with the profession in general. A short discussion period followed.

ROCKVILLE

F. TREWARTHA, M.E.I.C.,
Secretary

Du Pont Executive Speaks

J. A. Hornibrook, manager, textile bres division of Dupont of Canada addressed the Branch on January 15 on he subject of the Duke of Edinburgh's onference, which was held in the United ingdom, July 1956.

The main theme of the conference, Study of Human Problems in an Industrial Community" was sparked by the informal and personal interest of H. R. . The Duke of Edinburgh. One of 28 Canadians selected to go to the conference, Mr. Hornibrook found it a fascinating experience. The exchange of information between management and labour roups from all parts of the world enabled the conference groups to find a common approach to the impact of industrialization on the community.

Tours to study industrial communities were arranged and an opportunity was afforded to talk to people at all levels with complete freedom. Mr. Hornibrook was most impressed with the progress which had been made in planning community development. The formation of "satellite" communities around larger cities was well advanced. Excellent strides have been made with the diversification of industry, particularly in the Glasgow area.

Acute Problem. Mr. Hornibrook stated that the training and education of scientists and engineers was considered an acute problem in the United Kingdom. Due to the geographical nearness of Russia, British educators were ahead of their U.S. colleagues so far as providing advanced training for all qualified children, with government financial support. The speaker felt that British unions and management were well ahead of Canadians in studying the effect of "automation" on the worker.

Mr. Hornibrook concluded that the fruits of industrialization could be bitter or sweet, but that diversified industrialization must be fostered as the only way to raise the standard of living. He felt that the fruits of industrialization in Canada have been sweet and Canadians should consider themselves fortunate in living in a vigorous and expanding economy.

Chairman of the meeting was J. G. Kerfoot. The speaker was introduced by R. H. Wallace and thanked by R. M. Powell.

FREDERICTON

O. I. LOGUE, M.E.I.C.,
Secretary

G. R. W. BLISS, JR.E.I.C.
Chairman, Public Relations Committee

Films Follow Meeting

The February meeting of the Fredericton Branch of the Institute was held at Kent Inn on Feb. 11. Following a short business meeting, conducted by chair-

In this photo taken on the occasion of the visit of president V. A. McKillop to the Huronia Branch are, left to right, H. C. Bates, councillor of the Institute; Mrs. V. A. McKillop, R. MacKay, Branch chairman, President McKillop; Mrs. Bates and Frederic Alport. Forty seven members and guests attended the dinner for the first presidential visit to the Branch since its inauguration five or six years ago.

• BRANCH NEWS

man Ira Beattie, several interesting films were shown. These included an Italian film on the "Maccaferri Type of Construction" and a recent film on the St. Lawrence Seaway development. Briefly the "Maccaferri Type of Construction" consists of filling wire cages, about 3′ wide, 4′ deep and 5′ long with rocks, and laying the cages up in the form of a retaining wall to prevent erosion caused by mountains and rivers and also to keep the latter from eroding their banks away. About forty members were present for the showing.

On Friday, Feb. 15, the annual Engineering Ball sponsored jointly by the engineering students at the University of New Brunswick and the Fredericton Branch was held in the ballroom of the Lord Beaverbrook Hotel. About 150 couples enjoyed the music of the university orchestra directed by Paul Stewart and the refreshments available in the mezzanine. This dance is fast becoming one of the most popular social events of the year. Highlight of the ball was the crowning of the 'Engineering Queen', Miss Janet Hunter of Halifax, N.S., a first year student at U.N.B.

HALIFAX

J. E. REARDON, M.E.I.C.,
Secretary

G. H. DUNPHY, M.E.I.C.,
Branch News Editor

"The Evolution of Television"

On February 20 a meeting was held at the Nova Scotian Hotel to hear H. M. Smith, Maritime regional engineer of the Canadian Broadcasting Corporation, Sackville, N.B. who presented a talk on "The Evolution of Television". This was well received by the largest attendance this winter. Over ninety people were present.

Mr. Smith began his talk by describing the first concept of picture transmission. He pointed out that the characteristics of selenium with its variable resistance when subjected to different degrees of light intensity, lent itself to the concept of picture transmission. However, this was a bulky piece of equipment consisting of thousands of selenium cells connected by conductors to individual light sources at another location. The intensity of the light source was varied relative to the amount of light falling on the selenium cells. This experiment was undertaken as far back as 1870.

Present day sets have been developed from the cathode ray tube, which was conceived at the turn of the century and actual pictures were transmitted by this medium at that time. In 1911 an Englishman presented the theory of electron scanning and co-ordination between transmitter and receiver. This was the first concept of the present day television. However, the development of material and tools to accomplish this took several years, and it was not until early in the 1920's that they were able to use this method. Mechanical scanning was finally given up in the 1930's when they were able to improve on the camera pick-up tube or iconoscope.

After a question and answer period, H. R. Doane moved a vote of thanks for the speaker.

The group were conducted through all the technical departments of the Television Studios.

KINGSTON

D. I. OUROM, JR.E.I.C.,
Secretary-treasurer

Joint Highway Research Program

A meeting of the Civil Engineering Section of the Kingston branch was held on December 11, 1956 in Queen's University Memorial Union. Short addresses were read by four staff members of Queen's who are performing research work in the field of highway and traffic engineering.

Dr. S. D. Lash. The history and the terms of reference of the program were described by Dr. S. D. Lash, head of the civil engineering department and director of the newly formed Ontario Joint Highway Research Program. It was pointed out that active work will commence at Queen's in May, 1957. The program is financed by a grant from the Ontario Department of Highways. The University is to provide the staff to direct and perform various highway research projects in the area of materials, soils, pavement design and construction, maintenance, traffic and economics and administration. Queen's will also encourage work in highway engineering by developing course work in this field at the undergraduate level, and by establishing advanced courses for graduate students. It was explained that a similar arrangement has been made with the University of Toronto.

The program is administered by an advisory committee consisting of a total of ten members representing the Department of Highways, the University of Toronto, Queen's University, the Ontario County Engineers, and the Ontario Research Foundation. It is the function of this committee to approve budgets, assess proposed research projects and generally administer the entire program.

Dr. O. Martin. Two research projects which are being performed under his direction were briefly outlined by Dr. O. Martin, associate professor of civil engineering. One project involves the development of apparatus for the purpose of measuring the capillarity of soils in the field. It is believed that the development of such equipment will enable field engineers to exercise close con-

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trol over sub-base material, particularly in respect to the frost susceptibility of the material. The other project under investigation concerns the plant control of bituminious mixtures. In this project Dr. Martin is constructing apparatus to measure the permeability of the mixture. It is believed that such measurements can be correlated with such mix characteristics as density and voids content, and thus will permit an assessment of pavement quality in the field.

Professor D. L. Townsend. A research project dealing with the compaction of soils was described by Professor D. L. Townsend. The purpose of this project is to attempt to evaluate the accuracy of soil density measurement as obtained with various types of apparatus currently in use. Of great interest is the new Washington State Densometer which, it is claimed, will provide more accurate density measurements in granular materials than any other testing device. Studies were undertaken to test this equipment during the summer of 1956. The studies were also extended to obtain preliminary data concerning the effectiveness of various types of compacting equipment such as sheep's foot rollers, hyster grid rollers, wobble-wheel rollers etc. It is hoped this project will develop improved specifications regarding the use of the various type of equipment on different soils and also will lead to more realistic density requirements in pavement construction practices.

Dr. D. T. Wright. Research projects relating to highway bridges were described by Dr. D. T. Wright. A project concerning the evaluation of bridges with particular emphasis on load limits has been completed by Dr. Wright, and a report has been prepared and published. In addition, a tentative specification has been prepared based on the analysis of current practices in posting bridge load limits. These two reports represent the first completed project at Queen's. Work on this project was started in May 1955, in anticipation of the research program, and was completed under the terms of the research program in 1956.

A study of bridge vibrations is being undertaken by a graduate student under the direction of Dr. Wright. The field work for this project was started in the fall of 1956 and consisted of the measurement of the vibration of various bridges. These data are to be analyzed in order to develop what may be considered to be a limiting acceptable vibration for highway bridge structures.

An additional investigation has been started to develop equipment and procedures for the field testing of bridges. This project will involve the testing to failure of certain abandoned highway bridges in order to obtain information on bridge failure characteristics.

Traffic Engineering. Professor H. M. Edwards, associate director of the pro-

THE RED SQUARES INDICATE STRUCTURES BUILT ON RAYMOND FOUNDATIONS gram outlined the research activity in the field of traffic engineering. One of these projects involves the investigation of sample sizes to be used in the collection of origin-destination data. Present data collection procedures require relatively large samples which result in high survey costs. It is hoped that the savings in survey costs which would result if sample size reduction proves feasible, would be of sufficient magnitude to enable more municipalities to undertake these important traffic planning studies.

A study of highway speeds was undertaken in the summer of 1956. The purpose of this study was to establish driver speed characteristics on Ontario highways. It is believed that the data from this study will be of value to the designer in developing future design criteria and also will provide the facts necessary to improve existing legislation relative to speeds. Subsequently it is intended to statistically analyze the data in order to determine the effect on speeds of such variables as pavement type, pavement width, vehicle type etc. This study is to be performed annually in order that speed trends can be studied.

KOOTENAY

J. L. P. LIMBERT, JR.E.I.C.,
Secretary

G. T. J. HUGHES, M.E.I.C.,
Branch News Editor

Annual Meeting

The Kootenay Branch held their annual meeting in the Kootenay Hotel on February 19, 1957. Preceded by dinner, the meeting settled down to hear the chairman's annual report by T. W. Lazenby. Highlights of this report included the awarding of the Kootenay Branch Scholarship of $50.00 to Wayne Wharton. A student of Nelson High School he is attending Royal Roads College in Victoria.

The Branch also donated $25.00 to the Colonel By Memorial, and had forwarded $50.00 to the Institute from the proceeds of the showing of the Leonardo da Vinci film. The chairman reported that the past year had been an active one. Thirteen Branch meetings had been held and the visit of the general secretary had been much appreciated by all members.

Officers elected for 1957 were announced and W. G. Small, incoming chairman took the chair.

Guest Speaker. Dr. Colbert traced the early development of surgery from the year 1500 B.C. in India to the present time. He said that plastic surgery should be thought of as reconstructive surgery where defects in the human body were reconstructed to appear as normal. He described in detail the operations for reconstructiong the human hand to make it functional and also the treatment of badly burned patients.

Dr. Colbert illustrated his talks with slides showing various deformities of the body before and after treatment. He described the use of various methods and their limitations in reconstructing damaged parts of the body.

The thanks of the meeting were accorded to Dr. Colbert for his interesting talk.

LETHBRIDGE

R. D. HALL, JR.E.I.C.,
Secretary-treasurer

J. FISHER, JR.E.I.C.,
Branch News Editor

Joint Dinner Meeting

The Lethbridge Branch of the Institute held a joint dinner meeting with the Association of Professional Engineers of Alberta on January 26. Close to sixty members and guests were present. Chairman of the program was J. G. Dale, of Edmonton, president of the Association of Professional Engineers of Alberta. According to Mr. Dale, the Profes

sional Engineers' membership in Alberta is in excess of 2,000. Bruce Porter, of Lethbridge and recently of Calgary, an engineer with the Lethbridge branch of Calgary Power, was presented with a certificate of membership by the chairman. Mayor T. R. Haig of Lethbridge, extended greetings to the engineers on behalf of the City of Lethbridge.

Six hundred people attended the annual dinner-dance of the Montreal Branch in February. The above picture shows part of the head-table. Left to right are: Dean H. Gaudefroy, of the Ecole Polytechnique; Mrs. Leo Roy; E. D. Gray-Donald, past-chairman of the Branch; Leo Roy, Branch chairman; and Mrs. E. D. Gray-Donald.

Dr. T. A. Link Guest Speaker

A pioneer geologist in Canada, Dr. T. A. Link, of Calgary, was guest speaker. He discussed "Some Highlights of Early Geology in Canada", which dated back to 1919 when he was employed by Imperial Oil to begin exploration for oil in the North West Territories. Dr. Link described the excitement of shooting Smith Rapids, 16 miles of roaring water on the Slave River, in a river scow. The year 1921 saw Dr. Link aboard the first plane, a four-passenger CL-6, ever to fly into the Mackenzie River region. When the pilot landed at Hay River natives were found plowing with a dog team. The men had a great deal of explaining to do before the natives would believe the plane was not a bird or an ill omen. The first oil well in the Norman Wells Oil Field was brought in under Dr. Link's supervision. Twenty years later he returned and worked on the Canol Project which developed this oil field, the only one in the N.W. Territories. In 1947 the famous geologist played a major part in opening up the Leduc Field, which led to the oil boom in Alberta. Graphic as well as coloured slides added considerably to this interesting address.

Engaged in private practice, Dr. Link is a fellow of the Geological Society of America, the Geological Society of Canada, and a charter member and past president of the Alberta Society of Petroleum Geologists.

Musical entertainment was provided by Art Hunt who sang two numbers and by J. Horhozer who presented accordion selections. Brown's orchestra accompanied the guest artists and provided dinner music.

R. Peterson Addresses Meeting

R. Peterson, M.E.I.C., soil mechanics engineer of P. F. R. A., Saskatoon, addressed the Branch at their regular meeting February 16, 1957. Mr. Peterson stated that the Lethbridge district has more and larger earth dams than any other locality. The two largest earth dams in Canada are the St. Mary's

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Dam, south west of Lethbridge and the Travers Dam, north east of the city.

Mr. Peterson showed slides of various earth dams and of the methods and calculations used in their design. The three main problems in earth dam construction are seepage, slides and cracks. Construction is extremely important as even a well designed dam may fail if it is not properly constructed. Slides were shown taken at invervals of fifteen, thirty and forty-five minutes indicating the progression in the failure of a small dam. The dam failed completely two hours after the first sign of failure was noticed.

P. F. R. A. are now installing test apparatus in earth dams such as piezometers, settlement gauges, and inclinometers to record the actual performance of dams.

In conclusion Mr. Peterson stated that soil theories have many limitations since soil is extremely complex, and the approach using test apparatus appears to be the most practical.

Mr. Peterson's paper "Design and Construction of Earth Dams in Western Canada" appeared in the February 1957 issue of the Engineering Journal.

A gay after-dinner scene at 'Festa Italiano', the eight-course dinner-dance arranged by the Peterborough Branch in January.

PETERBOROUGH

D. B. CHASE, JR.E.I.C.,
Secretary-treasurer

Annual Ladies' Night

"Festa Italiano" was the theme of the dinner dance which marked the annual meeting of Peterborough Branch held 18 January at the Kawartha Golf and Country Club. With tickets sold out one week in advance, attendance was limited due to seating capacity. About fifty members with ladies and special guests attended "The Party of the Year".

Being carried on in the true Italian atmosphere the party lasted from eight o'clock to about 2 a.m. An excellent eight-course Italian dinner, including such delicacies as roasted sucking-pigs and Artichaut alla Castiglione e Grano Turco e Pomodore was served. The atmosphere of an Italian restaurant was achieved with well chosen decorations and tables set for eight. Well-known Italian songs were sung by a soloist during the dance pauses.

The party was under the patronage of H. R. Sills, vice-president of the E.I.C. and Mrs. Sills, and Ross Dobbin, past-president of the E.I.C. Special guests

• BRANCH NEWS

were the Honorable J. A. Dewart, mayor of the city of Peterborough and Mrs. Dewart.

Chaperones were R. T. Bogle and Mrs. Bogle, I. F. McRae and Mrs. McRae and J. H. Smith and Mrs. Smith.

The idea for this evening, so full of good fellowship, dining and dancing, came from M. M. Uloth, past chairman of the Branch and was carried out with the help of Bill Ackhurst, present Branch chairman, and other members of the dance committee.

NIPISSING AND UPPER OTTAWA

G. R. KARTZMARK, JR.E.I.C.,
Secretary

J. W. MILLAR, M.E.I.C.,
Branch News Editor

Municipal Law—Engineering

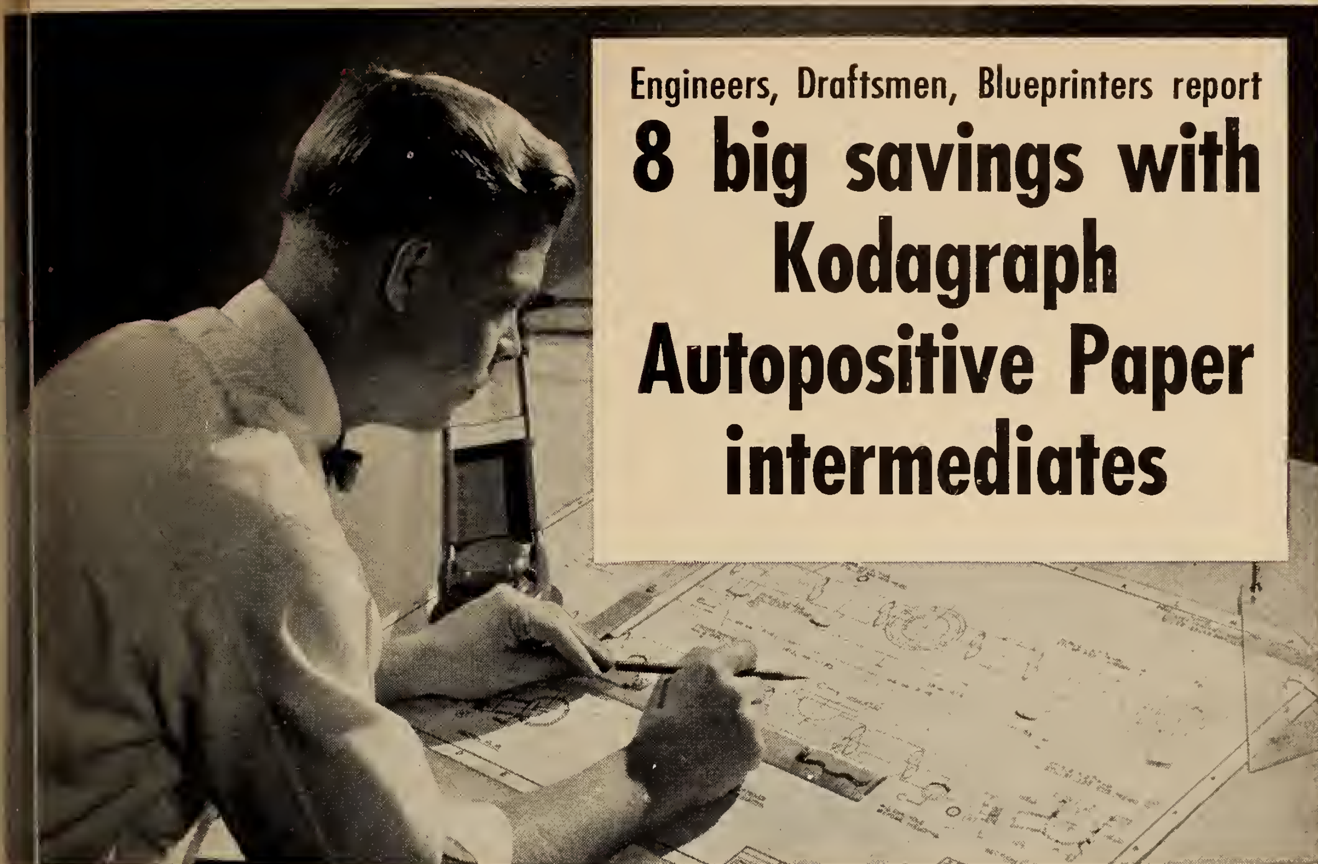
The regular monthly dinner meeting of the Nipissing and Upper Ottawa Branch of the Institute was held on February 6, in the Windsor Hotel at Sturgeon Falls, Ont. About twenty-five members and guests attended.

J. S. Cooper, councillor, reported on council meetings attended, with particular reference to progress on the matter of confederation of the Institute and the Associations of Professional Engineers. Mr. Cooper also reported that council was actively participating in an effort to supply travelling speakers and furnish educational pamphlets for prospective engineers. It was also indicated that due to the shortage now existing, a survey of engineering personnel is to be made on an international basis to obtain the best utilization of engineers.

Guest speaker was Thos. G. Farmer of the legal firm of Reynolds, Klein and Farmer at North Bay. Introduced by Mr. Macnabb, Mr. Farmer dealt with municipal law as related to municipal engineering, particularly referring to legal action by and against municipal authorities. He pointed out that municipal councils might be held responsible for wrongful acts of municipal employees. Boards and commissions are not necessarily responsible but the governing body would be.

Mr. Farmer explained that when action is to be taken against city management, notice of claim must be filed in seven days and action started in three months. Different degrees of liability with regard to sidewalks, cross walks and roadways was explained and the extent to which snow and ice create a liability.

New subdivisions came up for discussion and Mr. Farmer said that the financial burden imposed on municipalities, due to rapid expansion, had made it necessary for municipalities to make



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bylaws requiring subdividers to provide roads, sewers, etc., before any lots could be sold.

After an enlightening discussion period the meeting adjourned. Tom Chapman accorded Mr. Farmer the thanks of the group.

TORONTO

D. S. MOYER, JR.E.I.C.,
Secretary-treasurer

A. C. DAVIDSON, M.E.I.C.,
Branch News Editor

Students' Night Quizz

The annual students' night was held at Hart House on January 30. The event, directed by Dick Muller took the form of a quiz program modelled on the "$64,000 Question", with prizes of more modest dimensions. Seven teams representing the various clubs in the faculty of applied science and engineering were entered. With about 200 students present, it was one of the best turnouts to a students' night ever recorded in these parts. Thanks for helping to bring the students out through well planned publicity goes to Keith McIntyre, one of our recent student members.

H. L. Hinchcliffe kept things moving smartly during the questioning of the various teams. Four charming young undergraduates in the faculty, Jane Kerr, Dagny Vidinsh, Maire Keskula and Marlene Metzger acted as usherettes, leading the teams into the spotlight.

The Aeronautical and Engineering Physics Club took first place, winning $64.00 and four student memberships in the Institute. The Electrical Club won second place, getting $16.00 and four student memberships. All those who entered were awarded something, the last team being donated the price of that beverage popular among engineers, as a consolation prize.

Clips Presented to Student Members. Professor A. C. Davidson gave out tie clips to the student members who had recently joined the Institute. Coffee and doughnuts followed.

The President's Visit

On February 14, the Toronto Branch was honoured by a visit from President and Mrs. Vernon A. McKillop, accompanied by General Secretary, Dr. L. Austin Wright.

Arrangements were made by Keith L. McIntyre, S.E.I.C., for President McKillop to address the student body of the faculty of applied science at the University during the lunch hour.

Otto Renelt, third year class president introduced President McKillop, who complimented the engineering students on their contribution to the welfare of the community in physical labour and financially. The President had heard with pride that the engineer freshmen at Toronto had helped improve one of the city parks, and had aided the Community Chest last fall. The President discussed the increasingly important place of the engineer in Canada's expanding economy. The student might give more attention to the impact of his work on society. As a reward for his labours, the engineer would do well to take Wren's famous epitaph for his motto: "If you would see my monument look about you."

Discusses Institute-Student Relationship Dr. Wright spoke briefly about the Institute and its relationship to the stu dent at the university. Opportunities fo engineers are at their greatest at th present time. Employers come to the In stitute Employment Service looking fo engineers. If the salary offered does no meet the going rate, the prospective em ployer is told. In one such case, an ad vertisement was refused for the Journa because it would draw no replies, th salary offered being too small. The pros pective employer then looked into th present salary scales of his own enginee employees, and revised them upward

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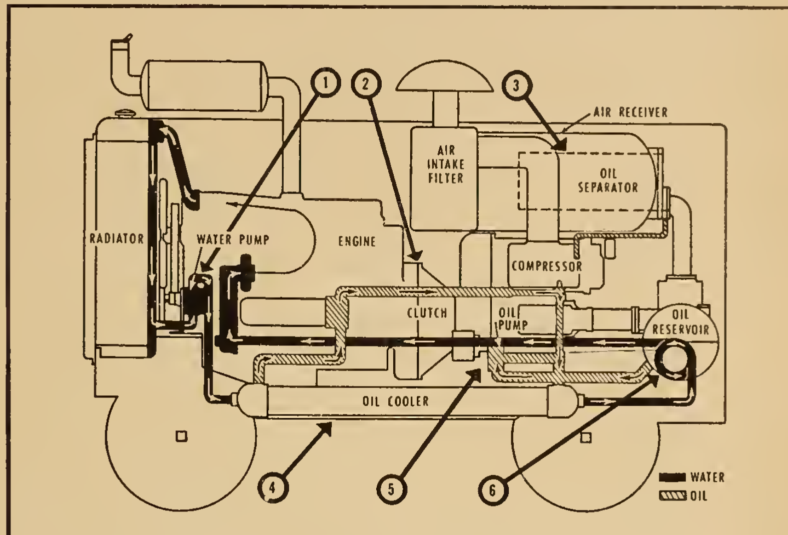

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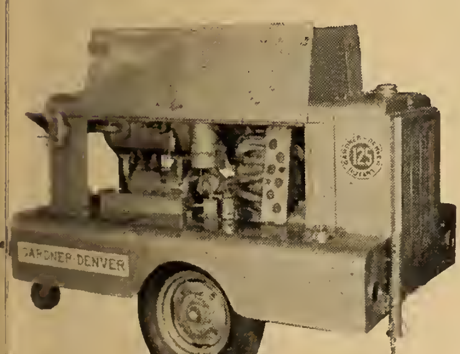

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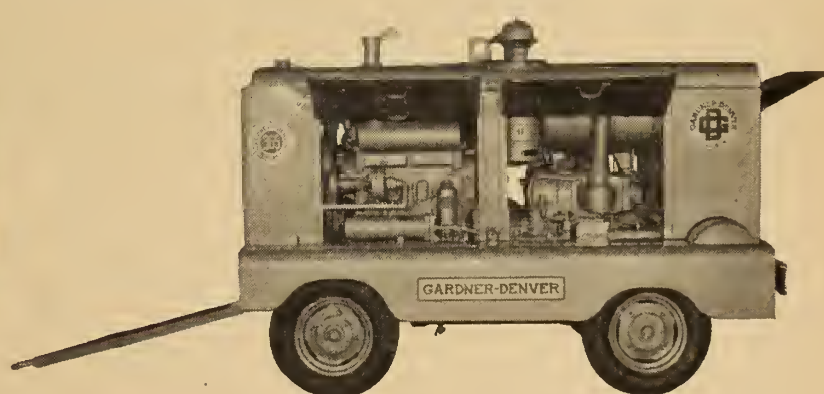

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Dr. Wright also dwelt on the service performed by the nstitute for the profession. A vital need in the life of any young graduate, he can obtain advice and help from members, technical advice may be obtained through the library and a suitable position may be acquired through it. The Institute is a coast to coast and international organization, in which the young engineer can feel at home.

Hungarian Students Introduced. One of the highlights of the meeting was the introduction of a number of Hungarian engineering students from the University of Sopron. One of the group, in Canada for only two and a half weeks, made a short speech in English, illustrating the determination of these young men to become good citizens as well as good engineers. The event was impressive.

Executive Meeting and Dinner. The president sat in the Branch executive meeting and commented on Institute affairs from his standpoint. Dinner at Hart House preceded a meeting at which the president discussed the impressions gathered during his term of office. There was a fast moving impression of activity, of things going on over the horizon, with an occasional close look, during his tour of the various branches. His most important recollection was of what constitutes the engineer's place in Canada. As for the economic picture of the country, the President felt almost optimistic. The gross national product was rising principally due to the efforts of the engineer. If the engineer were to fulfill his destiny and accomplish the things he must in the social picture in Canada, he felt that confederation of the Institute and the professional engineering associations was a vital necessity. Although dealings with other organizations of national and international importance, such as the Chamber of Commerce, and the Canadian Electrical Association were necessary, the relationship with the professional associations is of greater concern.

Discusses Confederation. There were many advocates of confederation. The picture was analogous to the political confederation of the Canadian provinces in 1867. It will take a strong leader to bring about confederation. It will require an act of faith and in spite of misgivings and unasked questions, good will come of it. The American picture is the only alternative. President Barker of the American Society of Mechanical Engineers has urged members of the Engineering Institute of Canada to make sure that confederation takes place; to take time and to do the job well. In the United States there are many organizations working at cross purposes, however some of this duplication has been corrected. Whatever comes, the same errors should not be committed in Canada. We must nourish, sustain, keep,


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• BRANCH NEWS

and build. As Francis Bacon said: "That which man altereth not for the better, time, the great innovator altereth for the worse."

Dr. Wright Discusses Spotlight Topics. Dr. Wright, the general-secretary of the Institute dealt with several important topics which presently hold the spotlight in Institute affairs. How to convey the meaning of the Institute to members is an urgent question. The average member has no understanding of the operation of the Institute. There is though, an upsurge of activity and a rebirth in all the branches. Three important undertakings have been made: the publication of Transactions; the development of Sectional Committees for technical meetings in the various branches; and a greater emphasis on the Professional Development courses.

Representatives in the engineering faculties have been appointed to foster Institute-undergraduate relations.

Dr. Wright also produced some novel forms of statistics to show how the "enemy within" apathy can be combatted. There were some 20,000 man-meetings in the branches across Canada last year. Dr. Wright gave statistics of the activities of the Institute library, the membership of branch committees, and the work of the Engineering Journal.

Having discussed confederation, the matter of refugee-engineers, and the shortage of engineers, the secretary closed his remarks with a hearty invitation to all those present to come to the next annual meeting which is to be held in Banff next June.

Joint Committees

The latest development in outdoor lighting were discussed by A. D. Harrington of the General Electric Company on February 5 at a meeting of the Toronto Branch of the Institute and the Institution of Electrical Engineers.

Mr. Harrington is the manager of the marketing development, outdoor lighting department of the company at Hendersonville, N.C. In this capacity he is well qualified to discuss the latest developments in ornamental and functional lighting.

A meeting of the Toronto Area committee of the E.I.C., the I.C.E., and the A.S.C.E, was held at the University of Toronto on February 7.

W. J. Fulton, deputy minister, designate, of the Department of Highways of Ontario addressed the group on "Planning for Future Highways in Ontario".

Mr. Fulton's paper dealt with the compilation of a report on the highway needs in Ontario for the next twenty year period. Outlining the problem briefly, it forecast the increase in traffic over the next twenty years, classified the highway system according to its service to traffic, and made an engineering study of the existing highway plant. The study is designed to expose highway deficiencies and point out improvement needed for adequate service to Ontario's burgeoning traffic. Having measured the lag, the report recommended the accelerated and continuing programs necessary to overcome it.

WINNIPEG

C. S. LANDON, M.E.I.C.,
Secretary-treasurer

Electrical Section Meets

On February 7 the Electrical Section of the Winnipeg Branch was addressed by A. Tallman, chief engineer of Pioneer Electric Limited, Winnipeg on the subject "Recent Developments in Large Air Cooled Transformers".

Discuss Air-Cooled Transformers. Mr. Tallman discussed air cooled transformers in general, giving details of the various insulation classes with their temperature limits. He then went on to discuss the design of a number of 5000 KVA air cooled transformers, designed and built by Pioneer Electric and recently installed in a large paper mill. These transformers incorporated forced air cooling.

Mr. Tallman gave complete details of losses, temperature rises, etc., at various loads with and without forced air circulation. He described in some detail the various steps which were taken to ensure that every part of the windings were adequately cooled. He also discussed the economics of forced air cooling and concluded that forced air cooling was a very desirable practice particularly in the larger sizes of transformer.

The question period which followed was particularly rewarding. Mr. Tallman is to be congratulated on producing a paper of a nature which promoted general discussion.

Conductor Aspects of High Voltage Transmission. On February 21, 1957 the Electrical Section of the Winnipeg Branch was addressed by Peter Malburg of the Aluminum Company of Canada. Mr. Malburg is a specialist in design problems of electrical conductors and spoke on the subject "Conductor Aspects of High Voltage Transmission". Mr. Malburg approached the problem of the design of a transmission line from the conductor point of view. The engineering and economic problems associated with the design of a high voltage transmission line are extremely complex but Mr. Malburg presented the problem very clearly and concisely and showed how all aspects of the design interlocked, the size of the conductors affecting the design of the tower and span etc.

In conclusion Mr. Malburg showed a film which had been produced in Finland, showing the construction of a high voltage transmission line in the Northern part of that country. The country through which the line was built was strikingly similar to that encountered in the Northern parts of our own province and was of particular interest for that reason.

VANCOUVER

A. D. CRONK, JR.E.I.C.,
Secretary

T. F. HADWIN, M.E.I.C.,
Branch News Editor

Inspection Trip

At noon on January 23, a field trip was made to the Pacific Coast Pipe Company Ltd. plant. The trip was arranyed with D. D. Reeve, M.E.I.C., chief engineer of the pipe company. About 50 members and students attended.

The visitors were shown all phases of wood stave pipe and tank manufacture from the receipt of the selected rough timber to the finished product. Large quantities of rough wood are stocked for air-drying and to provide the variety of sizes and lengths for pipe and tanks. Two items of particular interest were being manufactured at the time of the inspection. The first was large tanks being made out of staves of six inch square timbers of yellow cedar. The second was the largest continuous wood stave pipe in the world.

This latter pipe will be shipped to a point near Montreal where it will be assembled to deliver water at a maximum head of 90 feet, to produce 80,000 horse power. The diameter of this pipe will be 18 feet and its total length 5,600 feet in order to carry 2500 cubic feet of water per second. Two million board feet of lumber will be used which will require 150 railway cars to transport the lumber, steel cradles and metal fittings to the East. The lumber alone would build 200 average homes. A short section of the pipe was assembled in the Vancouver yard.

Lunch followed the tour and the thanks of the Branch was extended to the manager, T. A. Kennedy and staff.

Guest Speaker

On the evening of January 23, the regular meeting of the Vancouver Branch was held to view a film on Britain's "Calder Hall" atomic energy plant. Nuclear aspects were explained by Dr. G. M. Volkoff and heat transfer problems reviewed by Professor Wolfe, both of the University of British Columbia. Seventy-five members attended.

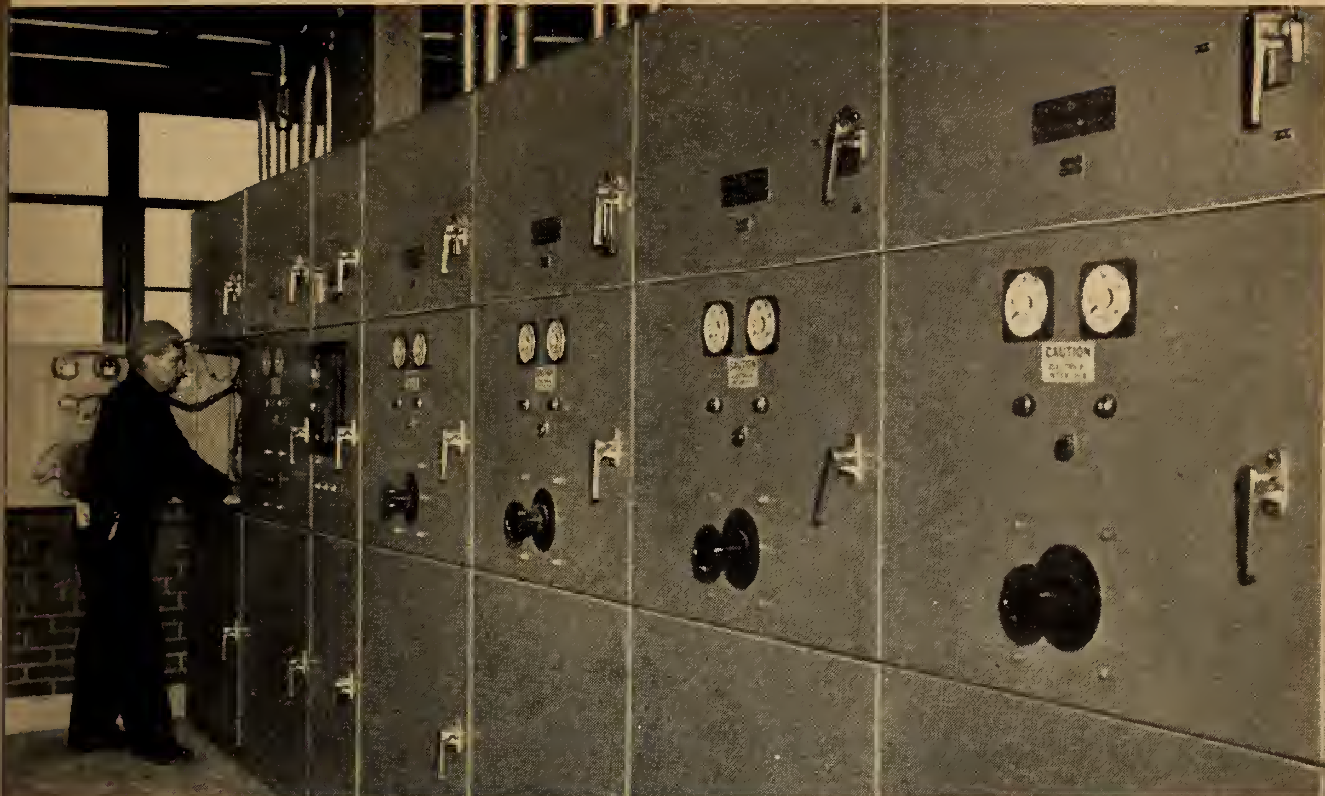
Dr. Volkoff stated that the prime purpose of the Calder Hall plant was to produce plutonium. Rather than waste the heat it was converted into electrical energy. The plant used natural uranium as would nearly all similar ventures outside the United States since this latter country was the only one with adequate facilities for producing enriched uranium.

Thermal Reactor Type. Since the plant is of the thermal reactor type and heavy water not readily available, graphite is used to slow the neutrons. Carbon dioxide at 100 lbs per square inch extracts the heat from the reactor and by means of heat exchangers supplies steam to the turbo-generators. Some idea of the magnitude of the reaction and associated equipment is indicated by the following illustration: the reactor enclosing concrete walls are seven feet thick, 1200 tons of graphite are required to moderate 130 tons of uranium, the uranium rods are in sections 1 inch in diameter and three feet long encased in magnesium cans and the cooling tower is equal in height to a thirty story building.

The film was of great interest but would not have been appreciated without the excellent background and comments given by Mr. Volkoff and Professor Wolfe. Vancouver is fortunate in having them in the area.

Professional Development

A standing committee of the Vancouver Branch of the Institute is that of Professional Development, chaired in 1956-57 by Commodore A.C.M. Davy, R.C.N. (retired). This committee, in cooperation with the Association of Professional Engineers of B.C. endeavours each spring to sponsor a course in Professional Development. This year a course on "The Engineer and the Law" commenced on January 30 and continued for a ten week period. A total of 210 registered and attendance taxed available space indicating that engineers still have a thirst for broadening their education.



Easy-to-service G-E Limitamp controls six 2300-volt synchronous motors —a total of 3800 horsepower installed at the Sarnia plant of Dow Chemical of Canada Ltd.

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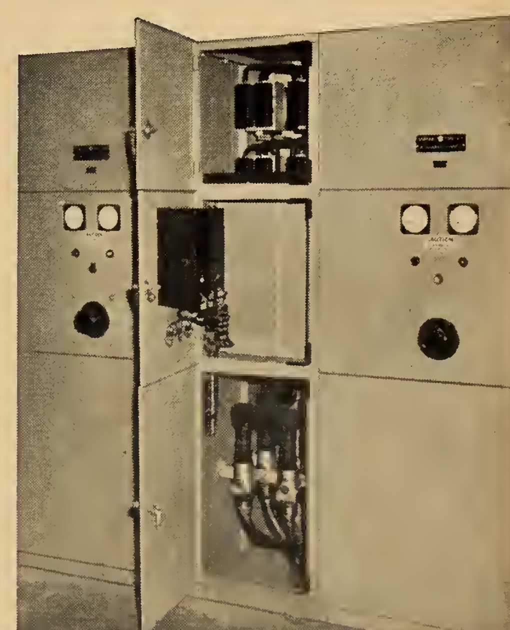
You enjoy safety too . . . gang-operated isolating switch, steel barriers separating high and low voltage compartments, enclosed bus compartment and reliable coordination of starter. For motors rated 2300 to 4600 volts G-E Limitamp Control also assures you of running overload protection and maximum safe-guard against short-circuit damage to starter and equipment. Back-to-back centre of room, back-to-wall, or mounting as free standing enclosure is possible with these units.

For complete application engineering service contact your nearest C-G-E Apparatus Sales office. Write for Bulletin No. GEA-6331, Apparatus Department, Canadian General Electric, 107 Park St. North, Peterborough, Ontario.



View of space-saving G-E Limitamp Control showing incoming cable and metering compartment.

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News of Other Societies

Commonwealth Mining and Metallurgical Congress

The Sixth Congress is being held in Canada this year, with major meetings scheduled as follows:

Vancouver, B.C., Sept. 8, 9, 10.
Edmonton, Alta., Sept. 16, 17.
Winnipeg, Man., Sept. 19, 20.
Toronto, Ont., Sept. 27, 28.
Ottawa, Ont., Sept. 30, Oct. 1.
Montreal, Que., Oct. 2.
Quebec, Que., Oct. 3, 4.
Halifax, N.S., Oct. 8, 9.

Communications about the congress should be addressed to: The Executive Secretary, 507-837 W. Hastings St., Vancouver 1.

Since the distribution by the Canadian executive office of the Congress of the first brochure, 3,150 inquiries from 75 countries were received, expressing interest. A second brochure giving detailed information, was circulated to interested persons.

Good progress has been reported in preparation of the Sixth Congress technical volumes: Mining in Canada; Structural Geology of Canadian Ore Deposits, Vol. II; The Milling of Canadian Ores; Case Histories in Geophysics; and Canadian Non-Metallics. The technical volumes, being prepared by the technical divisions of the Canadian Institute of Mining and Metallurgy, will be a most important feature of the Sixth Congress.

The general program and local programs are being developed. Meetings with local committees at almost all of the places in Canada to be visited by the Congress, indicate that every effort is being made to ensure a most successful and enjoyable Congress. Excellent co-operation is being extended to the Congress organization by the federal, provincial and municipal governments, by the mining, petroleum and other companies whose operations will be visited and by the entire Canadian mining industry.

Canadian Pulp and Paper Association

The Technical Section of the Canadian Pulp and Paper Association held the forty-third annual meeting at Montreal, January 23, 24, 25, 1957.

An extensive program of papers covered recent technical developments and scientific investigations of techniques being developed in Canada's leading industry. Management, fundamental and applied research were subjects of discussion, as well as training of personnel, and many other topics of importance.

Benjamin F. Avery, president and general manager of The KVP Company Limited, Espanola, Ontario, was elected chairman of the Executive Board, Canadian Pulp and Paper Asssociation.

John W. Wing, vice-president and general manager, Gaspesia Sulphite Co. Ltd., Quebec City, was elected chairman of the Technical Section.

The annual report of the Association, distributed during the meeting, stated that "In 1956, the pulp and paper industry broke many records. The over-all output of the mills of 11 million tons was greater than ever before and was nearly 6 per cent higher than in 1955. Production of pulp, newsprint, paperboard, fine paper, and wrapping paper reached new high record levels. And the value of the exports of the industry for the first time broke through the billion dollar level. Accounting thus for some 22 per cent of all exports pulp and paper continues to be the most dominant element in the foreign trade of the nation and a basic and essential source of the foreign exchange required for the imports upon which the progress of Canada depends."

Calendar

Welding

The Canadian Council of the International Institute of Welding (7 Pleasant Blvd., Toronto) has available programs for the annual assembly of I.I.W. to be held in Essen, Germany, from July 1 to July 6, 1957.

The official Canadian delegates, appointed by the Canadian Council are: R. A. Dunn, general sales manager, Canadian Liquid Air Company Limited; R. M. Gooderham, director, Canadian Welding Bureau; and H. Thomasson, manager, Metallurgical-Mechanical Section, Canadian Westinghouse Company, Limited. Mr. Thomasson is the chief Canadian delegate.

Chemical Engineering

There are three meetings of the Chemical Institute of Canada (18 Rideau Street, Ottawa 2, Ont.) scheduled as follows: May 15-17, joint conference, ACS Rubber Division and CIC Rubber Subject Division, Sheraton-Mount Royal Hotel, Montreal; June 3-5 the annual conference at Vancouver, B.C. October 9-10, divisional conference, Biochemistry Subject Division, Ottawa, Ontario.

Highways

The Canadian Highway Safety Conference, will be held April 23-25, 1957, at the Chateau Frontenac, Quebec.

The meeting will discuss highway safety problems related to engineering, laws and enforcement, education, motor vehicle administration anl public action. It will formulate plans for action acceptable to the federal government, provincial governments, provincial and community organizations for the reduction of traffic accidents.

Design Engineering

The second Design Engineering Conference and the second Design Engineering Show will be held in New York, May 20 to 23, 1957. The conference is sponsored by the American Society of Mechanical Engineers.

Industrial Engineering

The American Institute of Industrial Engineering will hold the eighth annual conference, in New York City, May 16-17, 1957.

Information can be obtained from the office of A.I.I.E. at 145 North High Street, Columbus 15, Ohio.

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Library Notes

Additions to the Institute Library
Reviews, Book Notes
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BOOK REVIEW

Samuel Smiles and his Surroundings.
Aileen Smiles. Hale, London, 1956. 206 p., 18/-.

This timely book, the family life of Samuel Smiles, 1812 - 1904, the Scottish author of "Self Help", is written by his granddaughter, Aileen Smiles, the niece of Mrs. Isabella Beeton.

To one brought up on "Self Help", in the day of mutual improvement clubs, mechanics institutes, board schools and parish councils, the memory of the "Sheffield Reformers", among the coal pits and their frequent explosions, the calico-bleaching fields of the West Riding of South Yorkshire, Miss Smiles' book is a carry back to early adolescence. And it is a most happy reminder that the life of the working man has improved almost beyond recognition, but "the fathers have eaten a sour grape and the children's teeth are set on edge."

Samuel Smiles, then a medical doctor, with degrees from Edinburgh and Leyden, visited Sheffield looking for work. The "Sheffield Reformers" included James Montgomery, editor and hymn-writer, and Ebenezer Elliot, the Corn Laws Rhymer. Smiles described Montgomery as a "pale, thin old man" Miss Smiles' quality of kindly reminiscence shows in her comment: "No wonder he looked pale and thin. He was accustomed to jail and had been there twice for publishing articles denouncing ordinary customs of the day — slave labour, state lotteries, employment of child chimney-sweeps."

We sing today in our churches—"Hail to the Lord's annointed" but do not know what social conditions were less than a hundred years ago when Montgomery wrote this as a Sheffield Editor, among the heavy industries of steel and coal.

Samuel Smiles was a worker. All his heroes were workers, some of them county aristocrats, like Dud Dudley, who first used coal to smelt iron instead of charcoal; Benjamin Huntsman, the Sheffield watchmaker, the inventor of cast-steel; Henry Bessemer, James Nasmyth, and others of the illustrious engineers, who succeeded against great difficulties through hard work. In later years it was the fashion to sneer at Smiles as an example of the *bourgeois* element of the Victorian population, the middle classes who worked for a living. He did and was proud of it. His strong appeal to the Englishman was his advocacy of common-sense, honesty and thrift.

Smiles led no narrow life, being in turn a doctor, a newspaper editor, a railway secretary, an insurance executive, and one of the most widely read biographers of Victorian times. But chiefly the men whose lives he wrote and in whose behalf he used his journalistic talents and great influence with learned societies and governments, were poor toil-worn geniuses.

Thomas Edward, the naturalist, of Banff, kept his wife and family by cobbling—"Puir Tam the cobbler", whose magnificent head made a sensation hung on the line at the Scottish Academy. Robert Dick, a baker, but also a poet and geologist, scattered spores about Caithness, so that it would be becoming beautiful "long after he was singing allelulias with the angels". Sir Roderick Murchison, director general of the Geological Survey, told the meeting of the British Association of this remarkable baker whom he described as "earning his daily bread by hard work, obliged to read and study by night, and yet able to instruct the head of the Geological Survey . . . and a profound botanist. I found to my humiliation that he knew infinitely more of botanical science than I did".

Smiles delighted to tell of pioneers, men of the mettle of the Stephensons, Watt, Davey, Trevithick, Smeaton, Nasmyth, Bramah, Fourdrinier, Babbage, Brunel, the Rennies and the Telfords.

"Lives of the Engineers" 1861 was — apart from the uniqueness of "Self Help", translated in his own lifetime into seventeen languages — the work for which Smiles became known to fame. It is best remembered among English-speaking peoples and the many nations they have now become, whose literature, art and science is native and yet inherited. The heroes of this book built ships, ports and docks, lighthouses, bridges, railways, highways, the world over and around. How many eager, bright-eyed boys and girls, of how many races, in how many lands, from tropic to arctic and antarctic zones, have been inspired by engineering ambition since our Roman legacy culminated in the year of the Diamond Jubilee, which Samuel Smiles then 75 years old, attended by special invitation. His granddaughter quotes from his letter of description of the ceremonies, written in what she affectionately, and very pardonably terms "Victorian Ecstasy" . . . "placed behind Sir Frederick Leighton and alongside Whistler with a splendid view of the Queen on her Coronation Throne, in the midst of her blooming family".

Granddaughter Aileen concludes her story of "granpa": "He is buried in Brompton Cemetery. I went there to find his grave, and to my astonishment found it. The grass was long, but there was a big plain stone:

'Samuel Smiles, Author of "Self Help"' still perfectly readable.

F. W. Gray, HON. M.E.I.C.

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS

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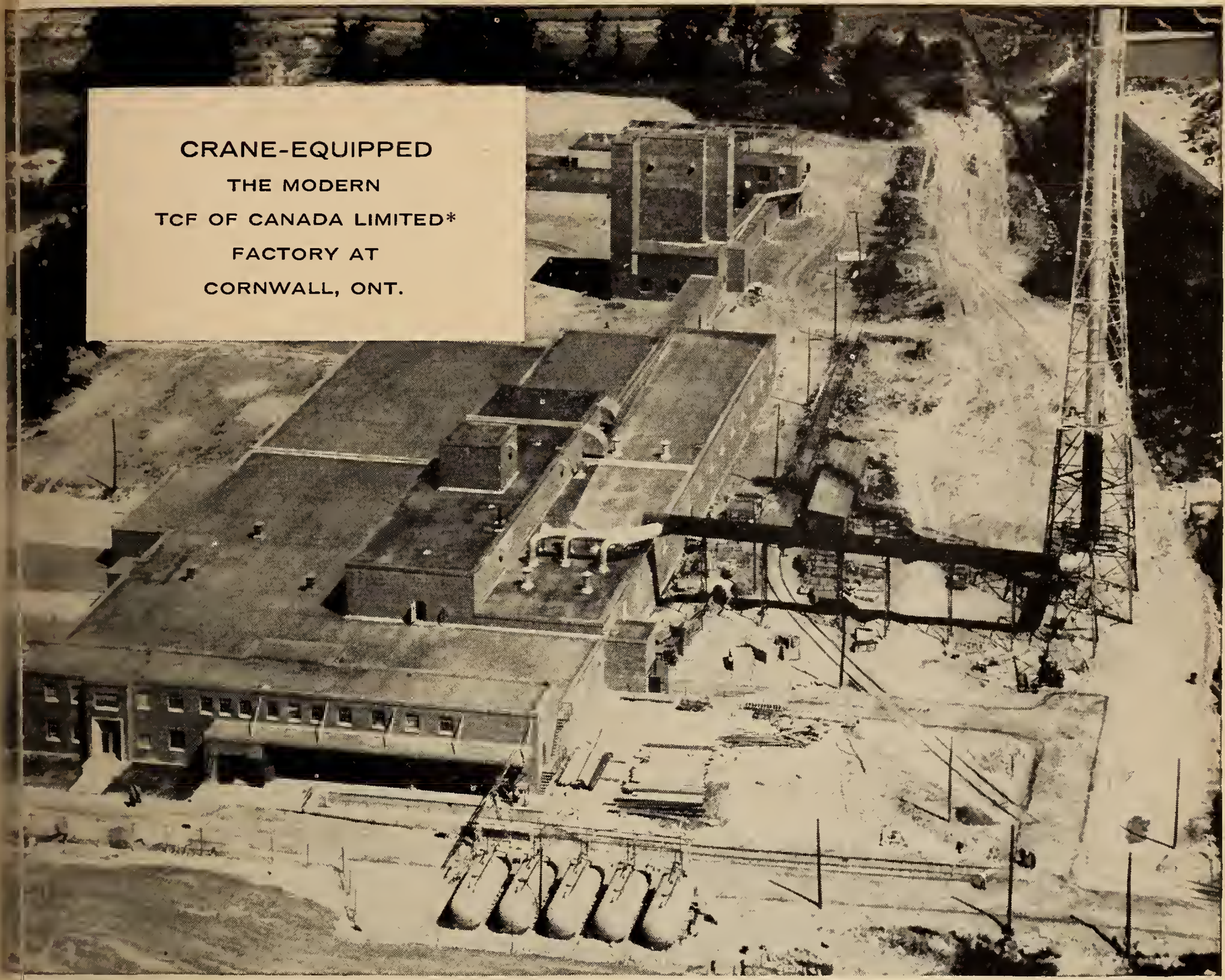
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BOOK NOTES

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*Book notes marked by an asterisk have been provided through the courtesy of The Engineering Societies Library in New York.

Alliages magnétiques et ferrites

M. G. Say, ed. Montreal, Fomac, 1956. 247 p., $9.20.

Translated from the English edition published in 1955, this book deals with the properties and applications in electrical engineering of magnetic materials, permanent magnet steels and alloys, permanent magnet ferrites, and magnetic powder cores. The related subjects of materials for magnetic recording and magnetostriction, and non-magnetic ferrous and magnetic compensating alloys are also treated, and an introductory chapter briefly reviews modern ferromagnetic theory.

***Appraisal and Valuation Manual of the American Society of Appraisers, 1956-1957, 2nd ed.**

New York, American Society of Appraisers, Manual Division, 1956. 516p., $15.00 (U.S.)

A large part of this manual consists of technical papers covering a wide range of subjects of interest to appraisers and valuation engineers: procedures, franchises, real estate, machinery and equipment, depreciation, rate of return, oil works, etc. A group of six papers is devoted to rate making for public utilities, and one paper deals with the valuation of an industrial atomic energy enterprise. The remainder of the volume is a directory of the Society.

***Arcs in Inert Atmospheres and Vacuum**

Electrochemical Society Symposium, San Francisco, May 1956. W. E. Kuhn, ed. New York, Wiley, 1956. 188 p., illus., $7.50.

Fundamentals, design and operation of furnaces, and chemical applications are the major phases of arc technology covered. Papers on furnaces deal with vacuum arc melting of refractory metals; a pilot-model, three-phase consumable-electrode arc furnace; electrode control systems; vacuum remelting of superalloys and steels; and German developments in vacuum arc melting of titanium and zirconium. Papers on applications deal with applications of the high intensity arc in metallurgy and in process chemistry, and with energy transfer in the high intensity arc.

***Bran's Equivalent Radio Tubes Vade-Mecum, 13th ed.**

Edited by J. A. Gijsen. Antwerp, Brans, 1957. 342 p., price not given.

A listing of available tubes by type and serial designation, with equivalent or near-equivalent replacement types given in parallel columns. Differences, internal construction, and characteristics of the equivalent tubes are indicated. Thirty-seven types of tubes from the principal makers in Europe and America are represented.

Cost Data for the Management of Railroad Passenger Service

D. R. Ladd. Boston, Harvard Business School, 1957. 345 p., $4.50 (U.S.)

The changes in transportation habits in America in the last few decades have resulted in severe losses for the railroads, both in passenger traffic and in revenue. This volume, by the associate professor of business administration at the University of Western Ontario, is based on research carried out at Harvard Business School on the subject of determination and control of costs.

Professor Ladd presents the types of cost data and cost concepts which management might use to control the deficit. He discusses the measures used to find the actual cost of running individual trains, of service between various places, and of related services, and suggests alternative methods which might present the data in a more usable form.

The book is based on information obtained from various railroads in the United States, and the Canadian National Railway.

• LIBRARY NOTES

Cours de mathématiques

J. Bass. Paris, Masson, 1956. 916p., 8500 fr.

The material in this book is that given in the mathematics course given at the Ecole Nationale Supérieure de l'Aéronautique and at the Ecole Nationale Supérieure des Mines in Paris. It presupposes a knowledge of elementry analysis and analytical geometry, and although it is not a treatise on applied mathematics, the author does point out the use of mathematics in solving problems.

Some of the topics covered include linear algebra, simple and multiple integrals, the Fourier integral, analytical functions and differential equations.

***Elasticity, Fracture and Flow; with Engineering and Geological Applications**

J. C. Jaeger. Toronto, Ryerson, 1956. 152 p., $2.25.

This is a concise exposition, for engineers and geologists, of the basic mathematics of the theories of elasticity, plasticity, viscosity, and rheology. The book is comprised of three chapters devoted to the detailed analysis of stress and strain; the behavior of materials (including criteria for fracture and yield); and the equations of motion and equilibrium.

The Electrical Year Book, 1957

Manchester, Emmott, 1957. 359p., 3/6.

Besides containing basic information on various types of electrical equipment, this edition contains revised material on thermal storage heaters, the regulation of the electrical equipment of buildings, electric cables, and tests useful in the installation and maintenance of industrial equipment. A number of tables are included.

Electronic Computers; Principles and Applications

T. E. Ivall, ed. Toronto, British Book Service, 1956. 167p., illus., $4.25.

An introduction to the subject of electronic computers, this book gives a general picture of the subject, and assumes only a basic knowledge of electronics and radio techniques, although several chapters require no technical knowledge to understand them.

Both analogue and digital computers are discussed, and the difference between the two demonstrated. The circuitry and construction of computers are described, and their applications considered. Reference is made throughout to computers actually in operation, mostly in the United Kingdom.

Elements of Engineering Materials

C. P. Bacha and others. New York, Harper, 1957. 494p., $6.50 (U.S.)

Intended for students in all branches of engineering, this introductory text discusses the elements and applications of all types of engineering materials.

The first four chapters cover such general topics as the properties and strength of materials and the structure of metallic materials. The metallic materials covered include iron and steel, alloy steels, copper, and aluminum and their deterioration and protection. Non-metallic materials include wood, cements, concrete, soil, stone, glass, plastics, rubber and fuels.

The scope of the work is so great that treatment of each material is necessarily brief, but the authors have included a bibliography of further reading.

***Engineering Uses of Rubber**

A. T. McPherson and A. Klemin, eds. New York Reinhold, 1956. 490p., $12.50 (U.S.)

A text and reference work for engineers outside the rubber industry who use rubber for applications in other fields. Consisting of sixteen chapters by eighteen rubber technologists, the book deals with methods of manufacturing rubber goods; properties; means of obtaining rubber products through purchase by specification or by special construction; and uses in electrical, civil and chemical engineering. Also treated are the design of mountings, tires, belt conveyors, rubber in automobiles, and rubber in aviation. The book concludes with a brief discussion of the molecular structure and mechanical properties of rubber.

• LIBRARY NOTES

°Handbook of Standard Structural Details for Buildings

M. S. Ketchum. New York, Prentice Hall, 1956. 120p., $4.65 (U.S.)

This is an illustrated guide to the preparation of working drawings for six types of buildings: a small house, a small masonry building, a reinforced concrete building, a steel frame building, an industrial building, and a timber building. Scale drawings of details of design are accompanied by descriptions explaining the reasons for including the details given and suggesting alternative methods of presentation.

°High Temperature—A Tool for the Future

Proceedings of a Symposium, Berkeley, California, June 1956. Menlo Park, Stanford Research Institute, 1956. 218p., $5.00 (U.S.)

The thirty-six papers included are about evenly divided among three major subjects: methods for obtaining high temperatures, materials for containing high temperatures, and processes occurring at high temperatures. The methods treated include solar furnaces, the carbon-arc image furnace, the short time electrical discharges, induction and resistance heating, chemical methods and nuclear methods. Papers devoted to materials deal with ductile ceramics, refractory coatings, selection of materials, and the interactions of materials with high temperature environments. Gas and condensed state reactions, and the interactions between gases and condensed phases are the chief processes discussed.

°Instrument Technology. Volume 2, Analysis Instruments

E. B. Jones, Toronto, Butterworths, 1956. 208p., $8.00.

A practical treatment of the basic principles, construction, installation, use, and maintenance of instruments for measuring the density, humidity, chemical composition, and viscosity of process materials. The aim has been to give as complete a coverage of available instruments as possible while emphasizing the more important and more common types. The instruments described are exclusively those of British makers.

The first volume, published in 1953, covered instruments for the measurement of pressure, level, flow and temperature, and included a bibliography.

Landslides in Clays

A. Collin (1846) trans. by W. R. Schriever. Toronto, University Press, 1956. 160p., $6.50.

This interesting text is perhaps one of the first books written on the subject of soil mechanics. Published in Paris in 1846 it seems to have been forgotten for nearly a century, until, through the efforts of Mr. R. F. Legget of the National Research Council, and a member of the Engineering Institute of Canada, this translation was made.

Collin presented theories of landslides; valuable field data, including surveys of shear surfaces, on about fifteen slips. He noted that they were deep rotational movements with a cycloidal slip surface and concluded that the cause was inadequate shear strength.

This book is a valuable addition to the history of soil engineering.

Leçons d'anglais scientifique et technique

P. Naslin. Montreal, Fomac, 1956. 391p., $9.20.

This publication is intended to familiarize French speaking engineers with scientific and technical terms in English. There are thirty-two chapters or 'leçons', each containing: a number of English sentences on a technical subject, with a corresponding translation in French, lists of the new words used in each lesson, giving the pronounciation, and idiomatic usage and variations. A simplified form of phonetic spelling is indicated throughout. The presentation is lucid and convenient.

°Lubrication of Bearings

F. T. Barwell. Toronto, Butterworth, 1956. 292p., $10.00.

A compact presentation of data drawn from significant work published in the last fifty years. Intended to aid the practicing engineer in the design of bearings, the book covers the nature of surfaces,

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Du Pont makes raw neoprene and "Hypalon" for sale to rubber manufacturers. These chemical rubbers are used by industry in a great variety of mechanical goods—conveyor belts, hose, cables—and other items. Du Pont neoprene and "Hypalon" also find their way into the component parts of consumer and durable goods of high quality.

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wear, viscosity, and other fundamentals, outlines the principles of hydrodynamic lubrication, and presents a tentative approach to design. Thrust bearings, concentrated contact bearings, externally pressurized bearings, and oscillating bearings are covered.

Mechanical World Year Book, 1957

Manchester, Emmott, 1957. 360p., 4/6.

This 70th edition of the year book contains a review of progress in the development of the steam turbine power plant. Its importance is emphasized because it is now the most important means of turning the heat of nuclear fission into electrical energy. The section on presswork is completely revised, as is the section on boiler mountings. Other topics covered include engineering materials, machine tools, etc. Mathematical and other tables are included.

Mechanisms and Dynamics of Machinery

H. H. Mabie and F. W. Ocvirk. New York, Wiley, 1957. 442p., $8.50.

Growing from a course given originally at Cornell University, this new text features a streamlined coverage of the elementary work, and devotes more attention to advanced topics.

The first section, on mechanisms, covers linkages, cams, gears, and provides an introduction to computing mechanisms and synthesis. Section two, on the dynamics of machinery, discusses the kinematics and balance of machinery, force analysis and vibration in machines. The text is illustrated by many examples, and problems are included.

A knowledge of physics, calculus, statics and dynamics is assumed in the reader.

Metallic Rectifiers; Principles and Applications

L. R. Crow. Indianapolis, Sams, 1957. 286p., $3.00 (U.S.)

The metallic or semiconductor rectifier is an important circuit component, for the purposes of rectification, instrumentation and control, and the conversion of alternating to direct current. Types of rectifiers discussed and compared in this publication are: copper-oxide, selenium, and magnesium-copper sulfide. Contents also include: rectifier circuits; applications of power and small current rectifiers; rectifiers as electrical valves.

The book is intended for those interested in the practical uses of metallic rectifiers. A bibliography is included.

*Methods for Chemical Analysis of Metals

American Society for Testing Materials, 1956. Philadelphia. 627p., $8.00 (U.S.)

This publication is a part of the Book of ASTM Standards and Complements Parts 1 and 2 which cover the metals. It contains all ASTM methods for chemical analysis of ferrous and non-ferrous metals and alloys, including spectrochemical analysis. There are ten completely new methods and recommended procedures including chemical analyses for electronic nickel and titanium. In addition, ten standards have been substantially revised. Diagrams of the apparatus and pertinent charts have been included in some cases.

Production Forecasting, Planning, and Control, 2nd ed.

E. H. MacNiece. New York, Wiley, 1957. 374p., $8.25.

The author's aim in writing this book has been to explain the engineering principles of production management, and has illustrated his text with actual examples.

New in this edition are chapters on automation, specialization, standardization and simplification, material on operations research and ratio-delay analysis, and on level production. Other topics covered include manufacturing planning, factory planning, sales forecasting, loading, scheduling production, etc. The final two chapters present a problem involving the complete forecasting, planning and control of a business, and its solution.

The book is based on the author's experiences in both the United States

and Europe. There is a useful bibliography of books on the topics covered in the text.

The Prospector's Handbook, 4th ed.

W. L. Goodwin. Gardenvale, Que., National Business Publications, 1956. 381p., $5.00.

This non-technical introduction to the science of prospecting is a useful quick-reference book for the prospector and others in related fields. The information it contains is especially applicable to Canada. Contents include: descriptions of minerals; mineral groups; rocks and rock structures; mineral deposits; and practical prospecting. This new edition has been brought up to date to include the new base metals and other minerals which have recently come into demand because of new industrial processes.

*Reference Data for Radio Engineers, 4th ed.

New York, International Telephone and Telegraph Corporation, 1956. 1121p., $6.00 (U.S.)

An extensive compilation of data most frequently used by radio and electronics engineers. Prepared by specialists, it covers properties of materials, design and operation of components and major items of equipment, control systems, antennas and propagation, and such special topics as electroacoustics, digital computers, nuclear physics, and Fourier waveform analysis. Numerous charts, tables and diagrams are scattered throughout the book, and glossaries and detailed explanations are included wherever it seemed advisable.

*Scientific Uses of Earth Satellites

J. A. Van Allen, ed. Ann Arbor, University of Michigan Press, 1956. 316p., $10.00 (U.S.)

This compilation of thirty-three papers represents current thought on the utilization of artificial satellites for scientific purposes. Among the subjects dealt with are the optical and visual tracking of a satellite; satellite instrumentation; meteorological observations from a satellite; cosmic ray observations; measurements of the earth's magnetic field; plotting out of the auroral zone; studies of ionospheric structure, and detection of meteoric particles. All the papers were presented at the tenth anniversary meeting of the Upper Atmosphere Research Panel, in January 1956.

Techniques de résolution des équations aux derivées partielles

J. Legras. Montreal, Fomac, 1956. 180p., $6.80.

The equations considered in this book, those of the second order with constant coefficients, can, as the author points out, be solved by either algebraic, numerical or graphic methods.

The author presents the different techniques used in solving the various types of problem, and the easiest method of calculation. The book should be particularly useful to students.

Theory of Land Locomotion; the Mechanics of Vehicle Mobility

M. G. Bekker. Ann Arbor, University of Michigan Press, 1956. 520p., diagrs., $12.50 (U.S.)

The author of this book was a Lieutenant Colonel in the Canadian Army until his retirement, and much of the work covered by the book was done from 1943 to 1946 under the auspices of the Canadian Department of National Defense, the National Research Council, and the U.S. Army Ordnance Corps. The book is based on a course given by the author at the Stevens Institute of Technology, 1950-52.

The author's aim in writing the book is to present the information available on the physical relationship between a motor vehicle and the environment of its operation, with particular reference to vehicles operating off the roads.

Some of the topics covered include: locomotion in nature and on wheels; morphology and mechanics of motor vehicles; problems of soil and snow mechanics; mechanics of a wheel; skis, sleighs and toboggans; dimensional analysis, testing and over-all economy.

There is a list of over three hundred references covering the work done on the subject, and although much progress has been made since the book was orig-

inally completed, it is still a very useful and comprehensive survey.

Thermodynamic Functions of Gases

F. Din, ed. Toronto, Butterworth, 1956. 2 vols., $12.50 per vol.

The surveys of the thermodynamic properties of gases found in these volumes were undertaken in connection with a scheme sponsored by the British Department of Scientific and Industrial Research. The work was done by various academic and industrial organizations.

There is an introductory chapter by the editor on thermodynamic diagrams and functions and their preparation.

Also a survey of information existing on each gas, and thermodynamic diagrams and sets of tables constructed from this information. Bibliographical references are given for each gas. The gases covered are; ammonia, carbon dioxide, carbon monoxide, air, acetylene, ethylene, propane and argon.

Further surveys will be published later.

Transistor Engineering Reference Handbook

H. E. Marrows. New York, Rider, 1956. 288p., $9.95 (U.S.)

There have been increasing transistor applications in power control, communications, manufacturing, consumer use, and various branches of engineering and scientific research. This book is intended to fill the need for a publication on transistors and the components of transistorized equipment for commercial use.

Data sheets are included covering: 200 types of transistors, 450 capacitors, 100 cells and batteries, thermistors and other miscellaneous components. Further contents are: a short general survey of transistors, including a useful bibliography; data on transistors; data on components and test sets; data on commercial applications. The information given is arranged according to the manufacturing company for the various transistor types.

The World Almanac 1957, 72nd ed.

New York, New York World Telegram, 1957. 896p. $1.25 (U.S.)

This new annual addition contains the usual collection of miscellaneous facts in the fields of biography, history, geography, economics, law and sports. Information is easy to find, and often in tabulated form. A summary of notable events of 1956 is included, the majority pertaining to the United States.

*World Symposium on Applied Solar Energy, Proceedings

Phoenix, Stanford Research Institute, (Association for Applied Solar Energy) 304p., illus,. $5.00 (U.S.)

The nineteen technical papers included in these proceedings deal with such subjects as solar machines and stills, high temperature furnaces, the heat pump, water heaters, cooling with solar energy, algae culture, electricity from the sun, and residential uses of solar energy. The proceedings also include a panel discussion on solar house heating and two round table discussions devoted to the architectural problem of solar collutors and the future of applied solar energy.

TECHNICAL BULLETINS AND PAMPHLETS RECEIVED

Atomic Energy

A review of applications of radioisotopes to engineering. J. L. Putman. (I. Mech. E. Advance copy)

Some safety considerations of nuclear power reactors. C. D. Boadle. (NECIES. Advance copy)

Symposium on applications of radioactivity in petroleum research and refinery operations (Tracerlab inc.)

Civil Engineering

British contributions to civil engineering. (Gr. Brit. Central office of information. Reference Division)

Concrete

Concrete control and construction. (Bul. 132)

Curing of concrete 1925-1955. (Bibliog. 18)

ylation unit of the new rofina Refinery at Point-x-Trembles, Quebec.

• LIBRARY NOTES

Widening and resurfacing with bituminous concrete. (Bul. 131) (All U.S. Highway research board)

Corrosion

Protection against the underground corrosion of steel. K. F. Tragardh. (Swedish State Power Board, blue-white series 16)

Symposium on high-purity water corrosion. (A.S.T.M. s.t.p. 179)

Electrical Engineering

The Electrical Research Association. Technical reports: — C/T114—An experimental study of wind structure (with reference to the design and operation of wind-driven generators) M. P. Wax. F/T182—An evaluation of two rapid methods of assessing the thermal resistivity of soil. M. W. Makowski and K. Mochlinski. G/XT87—Gas pressures produced by an arc in contact with urea formaldehyde in a closed arcing chamber. A. E. Holden and W. F. M. Dunne. G/XT91—Gas production and erosion of material by arcs in fibre tubes. L. Gosland and W. F. M. Dunne. G/XT94—Experiments on a "hard gas" switch at relatively small currents. Preliminary report. L. Gosland. IB/T21 Report on cast blocks of styrene-divinylbenzene copolymers. V. E. Yarsley Ltd. J/T166—Some approximate equations arising from the properties of steam at moderately high pressures and temperatures. J. H. Horlock. L/T321—The effects of small discharges on some insulating materials. N. Parkman. L/T323—Theory of linear systems. B. Gross. L/T343—Ultra-high frequency breakdown in irradiated parallel plate gaps. W. A. Prowse and P. E. Lane. L/T350—A study of ionization coefficients and electrical breakdown in hydrogen. A. Wilkes, W. Hopwood and N. J. Peacock. S/T89—Impulse puncture of solid sheets alternating with oil, and flashover of solid surfaces under oil. W. G. Standring and R. C. Hughes. T/T51—Further researches on the phenomenon of debris formed in a meter type bearing with special reference to osmium-rhodium/sapphire and diamond combinations. G. F. Shotter. V/T117—Ageing of electrical installations as indicated by the incidence of fires. L. Gosland. W/T30—The measurement of surface friction of grain to determine its moisture content. P. Finn-Kelcey and P. E. Clayton.

Convention on digital computer techniques. (I.E.E. Proc. v. 103, Part B, supp. 2, 1956)

Selecting materials for electrical contacts. V. G. Mooradian (*Materials and Methods*, Sept. 1956. reprint)

Servicing TV afc systems. J. Russell Jr. (Rider, $2.70.)

TV tube location and trouble guide. (Rider, $1.25.)

Engineering Education

The American system of education and training of mechanical engineers. H. S. Arms. (I. Mech. E. Advance copy)

Education of engineers in European countries. S. J. Davies (I. Mech. E. Advance copy)

Education and the cold war. J. S. Duncan (The Canadian club of Toronto)

Incentive wage systems. Bibliography.

The local union. Selected references. No. 72. (Princeton Univ. Industrial Relations Section)

Engineers

A survey of the engineering profession. Sept., 1956 (E.C.P.D. report)

Mineral Industry and Resources

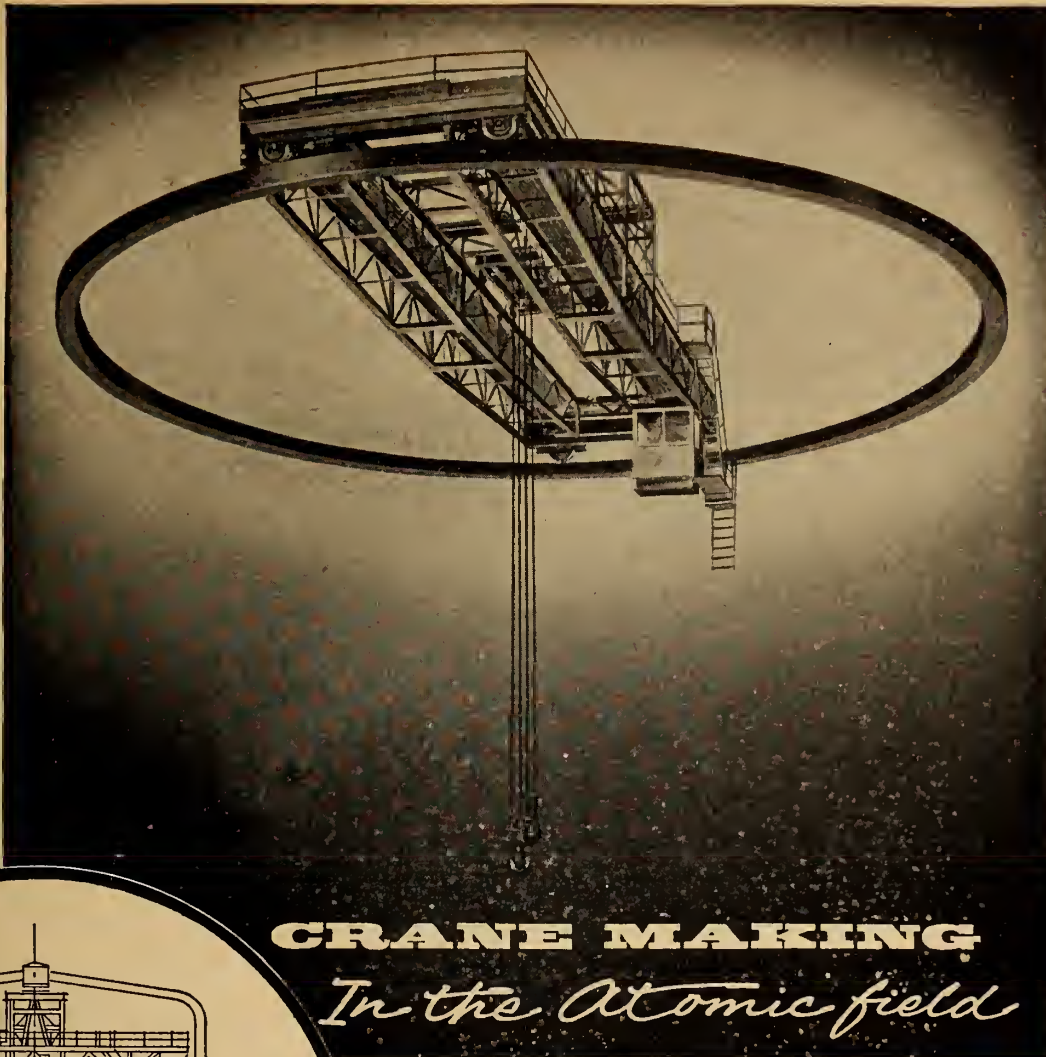
Description of mining properties visited in 1952 and 1953. (Quebec. Dept. of Mines. Mineral deposits branch, P.R. No. 330).

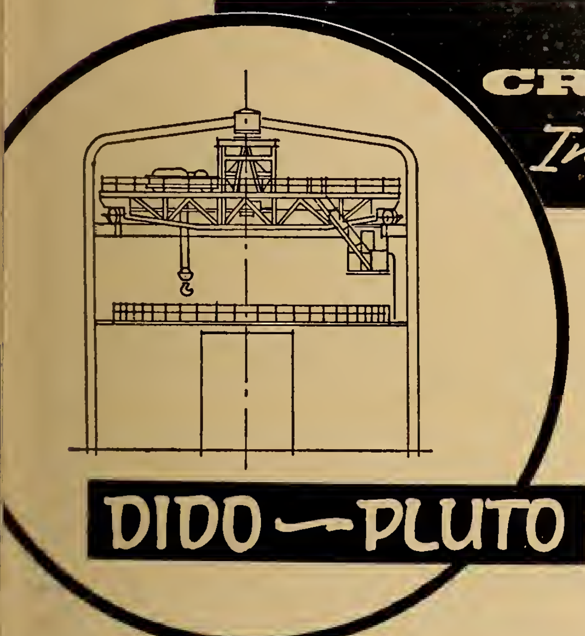
Milling plants in Canada. (Canada. Dept. of Mines and Tech. Surveys. List 1-2).

A report on income tax incentives for Canadian mineral development. J. G. McDonald. (Saskatchewan. Dept. of Mineral Resources)

Roads and Streets

Flexible pavement design correlation study. (U.S. Highway Research Board Bul. 133)





In collaboration with the Ministry of Works Engineering Staff we designed and installed a special form of circular motion Overhead Electric Travelling Crane, for operation in Britain's first experimental Reactor at Harwell.

We will shortly complete the installation of further circular motion units at both Harwell and Dounreay, the latter on instructions from the United Kingdom Atomic Energy Authority.

During the early part of 1957 we will commission a similar crane for the Australian Atomic Energy Commission.

The cranes are designed for a lift of 25 tons on a span of approximately 67 ft.

We are currently engaged in the installation of Main Turbine House and Blower House Cranes for Calder "B" and Chapel Cross Atomic Power Stations.

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hone: Melrose 1-3528 Grams: Marquipco, Montreal

MANITOBA, SASKATCHEWAN AND ALBERTA:
Mumford, Medland Ltd., 576 Wall Street, Winnipeg, Man. *Phone: 37-187; 37-188; 37-189; 37-180. Grams: "Mandem"*

BRITISH COLUMBIA, NORTH WEST TERRITORIES:
Gordon Russell Ltd., 2205 Fir Street, Vancouver 9, B.C. *Grams: "Rustle"*

Highway traffic estimation. R. E. Schmidt and M. E. Campbell. (Eno Foundation).

Road and street classification.

Road reference library. (Canadian Good Roads Association)

Miscellaneous

Chemical and mechanical stabilization. (U.S. Highway Research Board Bul. 129)

Research in automobile stability and control in type performance. (I. Mech. E. Auto. div. Advance copy)

A review of naval propulsion engineering progress in the last ten years. F. T. Mason. NECIES, 21st Parsons memorial lecture)

Society for Experimental Stress Analysis. Proceedings. v. 14, no. 1, 1956.

Some specialized uses of aircraft in the Commonwealth. (Gr. Brit., Central Office of Information. Reference division)

STANDARDS RECEIVED

A.S.T.M. Standards, American Society for Testing Materials, 1916 Race St., Philadelphia 3.

Benzene, toluene, xylene, solvent naphtha. 66 p., $1.50 (U.S.)

Building codes. Supplement to 1955 ed. 224 p., $275 (U.S.)

Zinc-coated iron and steel products 143 p., $2.25 (U.S.)

Supplements to book of A.S.T.M. standards 1956. 7 parts, ea. $4.0C (U.S.) *Part 1:* Ferrous metals. 440 p. *Part 2:* Non-ferrous metals. 360 p. *Part 3:* Cement, concrete, ceramics thermal insulation, road materials, waterproofing, and soils. 300 p. *Part 4:* Paint, naval stores, woods, sandwich construction, building constructions, fire tests, wax polishes. 230 p. *Part 5:* Fuels petroleum, aromatic hydrocarbons, engine antifreezes. 320 p. *Part 6:* Rubber, plastics, electrical insulating materials. 380 p. *Part 7:* Textiles, soap water, paper, adhesives, shipping containers, atmospheric analysis. 220 p.

British Standards, British Standard Institution, 2 Park St., London, W.1 Also available from the Canadia Standards Association.

B.S. 500:1956—Steel railway sleeper for flat bottom rails. 3/6.

B.S. 2094:1956—Glossary of terms relating to iron and steel: *Part 7:* Wrough iron. 3/-. *Part 8:* Steel tubes and pipes 3/-.

B.S. 2783:1956—Gamma-ray sourc capsules for radiography. 2/6.

CORRECTION

The price of the Encyclopedia of Instrumentation for Industrial Hygiene published by the University of Michigan was incorrectly quoted in the review published in the February issue of the Engineering Journal. It should be $30.00 (U.S.)

ENGINEERING CAREERS

The Construction Industries

THIS ARTICLE HAS been called The Construction Industries because there is no simply definable single industry that covers all the many kinds of construction work that are carried on today, especially in the more industrialized countries and those, such as Canada, that are expanding their resources rapidly and to a great extent.

The building of almost any structure or series of structures, from a farmer's barn to the St. Lawrence seaway and power development, could logically be included in an all-embracing "construction industry". In practice, there is a tendency for companies to specialize in particular fields of construction work, such as housing or commercial buildings, industrial plant construction, foundations and concrete structures, and so on. There are also many companies prepared to design and build for a great variety of industrial fields.

Large Employers

The construction industries in Canada are major employers of labour; in fact, the largest of the industrial groups (outside farming and commerce), with a peak total of some 650,000 employed in 1956. They are also large employers of engineers (a 1952 census of 4,040 civil engineers showed that considerably the largest group, of 700, were engaged in construction work—the total figure for the construction industries is, of course, much higher).

On-site consultations are frequent during the construction of industrial plants and other installations. Here, a group of designing and construction engineers discusses problems at the site of a new blooming mill for the Steel Company of Canada. In the background is the soaking pit area superstructure, seen nearing completion.

Fields of Work

The construction field is a wide one, as has been stated already. Among the facilities built, most of which will be familiar, are roads and railroads, airports and docks, tunnels and bridges, dams for hydro-electric power developments or flood control, and all the buildings (houses, offices, hospitals, etc.) that make up a residential community. In addition, there is the vast field of industrial construction, including mine facilities, powerhouses, and many different industrial plants for the manufacturing, chemical, petroleum, pulp and paper, and other industries.

Engineers in Construction

The activities of engineers in the construction industries may be divided roughly into two sides. On the one hand there is the design of the permanent structure, such as a building or a bridge, and on the other is the actual erection of the structure.

The design engineer is responsible for applying the theory of structures and his knowledge of building materials and their physical properties to produce a suitably practical, stable, and reasonably economical structure. In this task he may work in close collaboration with the architect.

The construction engineer is responsible for the work in the field, from initial surveying of a route or a building site to the completion of the structure—in other words, *how* the job is done. This may involve the design and erection of temporary structures, scaffolding, formwork, materials handling plant and equipment, and so on.

Types of Engineer

The construction industries employ more civil engineers than any other category, but mining engineering is also considered a valuable training for engineers wishing to enter the construction side of the industries (rather than the design side). In addition, however, there is scope for a considerable number of chemical, electrical, and mechanical engineers in the design and construction of industrial plants.

Progress and Opportunities

On the design side of the industries, an engineering graduate may start as a junior engineer in the drawing office of a company and progress through various stages to chief engineer and to management levels.

On the construction side, the graduate may start as a field engineer, working with survey parties or at construction sites, and then proceed to resident engineer, construction engineer and estimator, project superintendent, and supervisory grades to management.

Many of the top positions in companies engaged in the construction industries are occupied by professional engineers.

Widespread Activity

The activities of Canadian construction companies are mainly confined within Canadian territories, but the vastness of the country and its current rapid expansion mean that the construction engineer may find that his job involves covering a great deal of ground. The development of the mineral resources in the north involves the construction of whole townsites as well as the necessary mining and industrial facilities and the roads, railways, and airfields to make them accessible. The aluminum smelter at Kitimat, in northern British Columbia, is a well-known example of such a complete community in an area that is at present rather remote from main settlements. Similarly, the pulp and paper industry and, frequently associated with it, the hydro-electric power-producing centres undertake major construction projects in hitherto undeveloped areas.

The radar defence chains across the continent are further examples of widespread work for the engineer. Though Canadian engineers did not take part in the actual design of the Distant Early Warning Line (DEW-Line) in the far north, this part being done in the United States, they did play a large part in the construction work and were more widely concerned with the Mid-Canada radar line.

Canada is a major supporter of the Colombo Plan for financial and technical assistance to countries in the Far East. Several Canadian engineering firms are engaged in development and construction work in these areas.

Research

There is little pure research work carried out within the practical construction industries, but a considerable amount of such work is done at the universities and research establishments, in particular the National Research Council.

Training

The construction industries generally encourage the summer employment of engineering students.

The graduate engineer is given ample opportunity for practical on-the-job training and experience under the guidance of senior engineers. In addition, some companies offer assistance in the form of scholarships and facilities for further study, either externally or within the company.

Salaries and Benefits

General starting salary scales are comparable with other industries and are based on the recommended practice of the general body of professional engineers. The industry is a very active one, and the opportunities for advancement are currently very favourable for the right man. The upper limits of salary are related to the responsibilities of the higher levels of management to which the professional engineer may progress in the construction industries.

In common with general industrial practice today, additional benefits such as pension and health plans are customarily offered by the construction industries. Bonus and profit sharing schemes are also frequently incorporated, according to circumstances.

Construction of routes to open up new territories and to improve communications between existing communities is a continuing task. Shown here are two engineering undergraduates working with a construction survey party on a new trackbed for Canadian National Railways, typical of such construction work in various fields.

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In every corner of the nation, Canada Wire engineers demonstrate their renowned ability to combine the exacting principles of product engineering with the practical applications on the job.

Frank Ashworth,
Manager,
Product Control

v:ien the sun goes down

'ìis is Canada at night. Seen from te air, the twinkling lights of cities, t.wns, villages and farms virtually in-t·connect the oceans. If we could ·ew it all at once, this panorama ›uld still prove to be one of science's ;eatest achievements.

'ansmission of power from generator t population centre is a formidable ‹ough problem.

]it distribution of that same power to light up evergrowing communities is a science in itself.

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• **Month to Month**

(Continued from Page 453)

B.C. Welcomes Hungarians

The Journal *reprints this article from* U.B.C. Reports *because it agrees heartily with the ideas expressed. The Institute members and council have a warm interest in the welfare of these new Canadians and there is much pleasure in knowing that the University of British Columbia is doing so much for them.*

"Welcome Hungarians"

We are indeed fortunate in having the faculty and students of Hungary's only school of forestry come to Canada. We welcome them with open arms.

These are the people who jokingly claim that Hungary should have been awarded ten, not nine, gold medals in the Olympic Games "because we threw the hammer and sickle the farthest." These are the people who set up a free government in Sopron and ran the affairs of their city (nicknamed "The Faithful City") during the Hungarian revolution. They dug in to defensive positions around their city and retreated across the Austrian border five miles away only after the onslaught of hordes of Russian tanks made their cause completely hopeless.

They are a school with perhaps more "school spirit" than we have ever seen. They were originally an independent forestry school in northern Hungary until the border changes after the First World War moved them into Czechoslovakia. So they packed up and moved to Sopron. When the Treaty of Versailles ceded Sopron to Austria they were the prime movers behind a local plebiscite which got them back into Hungary.

They are proud people with a rich heritage and with an intense desire to learn the way of their new homeland. They bring with them a student orchestra (minus instruments), a soccer team, tennis champions, fencers, skiers. In fact, all that one might expect of an active student group anywhere.

They come at a time when Canada's forest industry badly needs talent such as they can offer or will be able to offer after they learn English and complete their training in forestry. The shortage of trained foresters is so acute in Canada that even with their arrival we must not let up in our efforts to recruit more and more young people for careers in forestry.

Once they learn the ways of our forests and the problems created by vast sizes and distances, they, with their different background and earlier training may make valuable contributions that no one else could make. Their approach to conservation problems alone, could in ten or twenty years' time make us extremely grateful for their presence.

Yes, we welcome them with open arms, and hearts. Let us try as hard to understand them and help them with their problems of adjustment to a completely foreign way of life as they are trying to understand us and learn to take their places as valuable citizens in our midst.

Election and Transfers

At the meeting of council held at Montreal, March 2, 1957, a number of applications were presented for consideration and on the recommendation of the Admissions Committee, the following elections and transfers were effected:

MEMBERS: V. Aare, Peterborough; S. Andrews, Vancouver; H. B. Ashenhurst, Burlington, Ont.; H. R. Bell, Vancouver; W. G. Brown, Montreal; K. C. Cox, Toronto; P. W. Doddridge, Peterborough; C. S. Elliott, Hamilton; J. P. Genge, Niagara Falls; L. Gill, Sudbury; R. F. Goodsman, Montreal; P. Heggs, Hamilton; I. C. Herd, Peterborough; E. C. Hurd, Vancouver, H. W. Jewell, Toronto; S. L. Lipson, Vancouver; A. B. Patterson, Toronto; R. H. Pinault, Arvida; R. A. Pope, Vancouver; S. Rolko, Hull; R. C. Steele, Montreal; F. X. Tremblay, Montreal; Z. C. Van Schwartz, Hamilton, Ohio; W. Villain, Dryden; J. D. Willis, Peterborough; H. R. Wright, Vancouver.

JUNIORS: G. R. Bowes, Prescott; R. M. Hanna, Grand'Mere; J. W. Smail, Ottawa; V. Tamm, Vancouver; J. C. R. Warren, Niagara Falls; K. M. Williams, North Bay.

JUNIOR TO MEMBER: J. E. Butler, Toronto; R. E. Dyson, Esquimalt; J. P. Ofrenchuk, Toronto; C. Senneville, Montreal; M. M. Smith, Toronto; H. D. Walford, Montreal.

AFFILIATE TO MEMBER: P. A. O'Connor, Col., Ottawa.

JUNIOR WITH EXAM: D. R. Morrison, Lively, Ont.

STUDENTS ADMITTED:

Queen's University: J. C. Aitken, D. H. Annala, R. W. Ansley, P. R. Barnard, J. J. Bawden, R. A. Bird, M. A. Bohn, H. J. Brooks, R. A. Brown, W. D. Budworth, J. R. Burton, R. A. C. Calder, E. Cappellani, W. Cencich, R. E. Chambers, N. J. Cowan, J. R. Eickmeier, O. K. Ellis, D. G. Foley, J. L. Gassenbeck, T. J. R. Godfrey, J. A. U. Gregg, J. V. Harvey, G. A. Hawley, B. L. Hodgins, R. F. O. Hurrle, A. A. Jackson, H. R. Johnson, W. H. Kerr, D. J. Kilgour, E. Koczkur, L. E. W. Laviolette, O. Legein, G. O. Leonard, D. C. Loucks, J. P. MacGowan, L. R. McCartney, A. McConnell, R. M. McDerment, R. J. McKelvey, A. M. McMahon, N. Moffat, E. A. Robertson, R. J. Rodger, P. M. G. St. Rose, O. J. Salari, D. S. Scott, W. R. Sexsmith, D. A. Sharp, J. C. Simons, J. D. Smith, J. F. Smith, A. M. Spriet, D. E. Staveley, D. Suzuki, R. K. Thom, J. M. R. Thomson, K. D. Trebilcock, A. G. Tucker, L. R. Tucker, W. P. Tuisku, C. J. Turkstra, N. Van Den Assem, M. R. Vanderburgh, E. C. Walker, J. E. C. White, M. M. Yovanovich.

McGill University: G. W. K. Adanuvo, J. F. Annesley, R. Borland, S. Broccolini, G. J. P. Comtois, M. J. Green, R. D. Hatfield, A. A. Lawless, F. Libera, R. Latham, A. R. McKim, W. Maslowski, B. Methoti, P. Moller, J. C. Noel, F. M. O'Shaughnessy, T. D. Owusu, R. M. Patterson, G. M. Roger, K. Takahashi, H. G. Walsh.

University of Toronto: J. M. Agnew, M. R. Binkley, J. J. Boase, A. Budra, G. S. Cohen, J. M. Corbett, D. J. Douglas, W. H. Eatock, R. L. Heise, P. Jelaffke, M. A. Krebs, C. A. Laferriere, D. A. Oakes, B. Ovenell, K. E. Plumb, E. J. Rohacek, F. C. Schwenger, V. Spring, W. C. Tripp, L. J. Westwood.

University of Manitoba: K. J. R. Blowatt, D. A. Campbell, R. M. Gordon, W. Hanuschuk, C. L. Hardy, D. J. Palanuk, C. J. Shirtliffe, F. F. Van Humbeck.

Nova Scotia Technical College: J. H. Arkwright, C. R. Baird, W. D. Blue, L. J. Cole, A. E. Keddy, W. H. Waring.

University of New Brunswick: J. R. Carmichael, J. D. Coletsos, C. H. Laurence, W. J. Starr, T. V. Stephens, T. A. Wilson.

Mount Allison University: D. A. Darby, M. G. Meacher, W. Szeto, W. A. Winsor.

Memorial University: R. I. Avery, L. D. Baikie, L. S. Cooke, A. R. Knight.

University of Alberta: J. K. Burrell, G. R. McAtney.

University of British Columbia: K. M. Johnson, T. D. Peters, J. R. Carmichael.

University of Sherbrooke: J. R. G. Chaperon.

Laval University: J. M. Levesque.

Royal Military College: R. G. Blakely.

Graduates: C. L. Hickson, B.A.Sc. (Mech.), Toronto 1956, F. E. Lucas, B.A.Sc. (Elec.), Toronto 1956, S. M. Uzumeri, B.A.Sc. (Civ.) Toronto 1956, C. L. Pelton, B.Sc. (Elec.), Queen's 1956, J. H. Simpson, B.Eng. (Elec.), N.S.T.C. 1956.

Applications through Associations:

By virtue of the co-operative agreements between the Institute and the Associations of Professional Engineers, the following elections and transfers have become effective:

ALBERTA

Junior to Member: P. A. Brett, J. D. Harper, J. E. Maybin, C. H. Weir.

SASKATCHEWAN

Members: R. G. Campbell, J. B. Dickey, B. B. Grant, H. R. Holland, J. A. Kelly, K. C. Reeves, P. E. Reimer, H. D. Ramsay.

Juniors: N. E. Parsons.

Students: H. G. Gilchrist, H. J. Girgulis, W. A. Maki, D. P. Mitchell, D. J. McGuire, R. D. McLeod, B. J. Pfeffer, E. W. Reinhardt, I. B. Wilson.

Junior to Member: D. Bing-Wo, J. C. Browning, S. S. Gray, R. A. Gyles, J. C. MacKay, D. E. McGrath, N. Peters, M. Shayna, C. L. Slegel.

Student to Member: B. I. Jamieson.

Student to Junior: T. P. Gilchrist, E. S. Jonasson, H. G. Kindred, A. Schuster, J. Stoffel.

NOVA SCOTIA

Members: J. Apinis, J. H. Walker.

Junior to Member: F. L. Mason, D. C. Tibbetts

THE ENGINEERING INSTITUTE OF CANADA

1956

REPORT of COUNCIL

and

Reports of Committees and Branches

Published as a supplement to the issue of *The Engineering Journal* for April 1957

APRIL 1957

CONTENTS

Report of Council, 1956

TO PARAPHRASE an old political cliche from south of the border—"As the nation goes, so goes the Institute", meaning simply that when Canada has a good year, so do its engineers. 1956 has again strengthened that view. The Institute has behind it another satisfactory year.

However, to say that the twelve months since the last report had been good in all respects would be evading the truth. Consider the matter of membership. The details in this report show that 1800 persons applied for admission to the Institute in the year. This in itself is very good, and stands 17 per cent higher than the corresponding number for the previous year.

At the same time, the net gain in overall enrolment was 510. This results, of course, from the application of casualties which occur through deaths, resignations, and removals. Details will be found later in the report. To understand properly what might be considered a high level of removals in 1956, one must be realistic about present conditions. Hundreds of engineers, particularly the younger ones, are on the move, often without leaving any forwarding address. The Institute loses contact, the mail is returned, and eventually a removal must be put through. Branches are urged to do all they can to keep tracing these members, and to send in new addresses as they become known.

As seen through financial eyes, 1956 again showed a sound and progressive position. The figures will be found elsewhere in this report, for those who wish to study them. It will suffice to say here that all expenses have been met from current revenues, satisfactory allocations have been made to reserves, and a small surplus remained.

The activities of the Institute have continued to expand, in several interesting directions, as this report will show.

CONFEDERATION

Confederation remained one of those subjects foremost in members' minds during 1956. The year saw the presentation of the joint report, to the Institute Council and to the Dominion Council, at their respective annual meetings, both in the early summer. The report was promptly adopted by the E.I.C. Council. Dominion Council decided that it would be essential to have the opinions of each one of its constituent provincial associations. As a consequence, the report was referred to all provinces for study and recommendation, and that is where the proposal now stands. The next move must come from Dominion Council, after receiving the reports of the provincial associations.

THE PRESIDENT'S ACTIVITIES

In addition to giving his personal attention to a host of Institute affairs from his own desk, Mr. McKillop, accompanied by Mrs. McKillop, undertook the president's annual travel schedule. In the early Fall, he attended the Maritime meeting at St. Andrews, New Brunswick, and combined with this his visits to many of the branches in that area, including Newfoundland.

The president's party was nicely on the Wester tour when the trip was suddenly interrupted by tl necessity of the president returning to his office b cause of the death of his senior assistant. The balan of the tour was continued by the general secretar with vice-president R. M. Hardy, from Edmonton.

Not less important were Mr. McKillop's several tri to represent the Institute and participate in the mee ings of other societies abroad. This is a phase activity which is increasing in scope, and which steadily raising the stature of the E.I.C., and of Canac in the technical eyes of the free world. These vis included several to the United States, and one to t conference of U.P.A.D.I. (Pan American Federation Engineering Societies) in Mexico City, as a result which the Institute will be hosts to that organizati for its 1958 conference, in Montreal.

COUNCIL MEETINGS

Council of the Institute met ten times during t year, at Peterborough, Ottawa, St. Andrews, Victor and Montreal. The average attendance was 29.

THE BRANCHES

In making any report of an Institute year, Coun remains conscious of the fact that the branches the Institute. It is on the vigour of their local activit that the health of the organization depends.

It is not the purpose of this part of the report discuss these branch activities, and it will merely stated that branch programs for 1956 reflected a h level of interest and a wide variety of ideas, b technical and social. In later pages members will f the details in the individual branch programs.

The number of branches during the year remai unchanged at 47, with seven branch sections.

PUBLICATIONS

Some interesting developments took place du the year in this field. First, the decision was taker make a change of printer for *The Engineering Jour* As the result, commencing with the July issue, *Journal* has been printed, bound, and mailed by H C. MacLean Publications Ltd., of Toronto. This course includes the report you are now reading. change has been a satisfactory one, from the Instit point of view, and the cost of publishing was stantially lower for the last six months of the y At the same time, advantage was taken of the cha over to re-vamp and improve the format and cont arrangement of the *Journal*. Comments have been vourable.

Two new publications were brought forth du 1956. The long sought pamphlet on the theme of "W should I belong to the Institute?" was compl printed, and distributed. It is now in steady den from the branches. The other item, also long awa was the compilation of an E.I.C. film catalogue. experienced man was given this task during the Sun and the book was finished and distributed in the Fall. The catalogue is one of the most comprehe its kind ever attempted in Canada. It will be useful branches, at universities, and to anyone concerned th the selection of films for engineers.

TECHNICAL ACTIVITIES

The year saw the gradual advancement of the w ideas on the technical activities of the Institute hich were explained in the annual report of a year o. A report of the special Committee on Technical perations was adopted, after prolonged study and dis ission by Council, and the proposals have now been omulgated to branches for review. In this connection l members are urged to read, if they have not ready done so, the explanation of this matter which as published in the February 1957 issue of the *Journal.*

As a further step, approval was given by Council the employment of an assistant secretary for promo- n of branch technical development, and his assistance ill be available as soon as a suitably qualified person n be found. Negotiations toward this end are now ogressing.

I.A.E.S.T.E.

In 1956 the Institute again acted as the Canadian gency for the administration of the International As- ciation for the Exchange of Students for Technical xperience. This marked the fourth year of Canadian rticipation in the plan, and the numbers of students ndled has been growing, not spectacularly but stead- . It is for the benefit of undergraduate engineering udents, to help them obtain technical employment broad during the summer vacation preceding their nal year. This past year 91 European students were aced in industry in Canada, and 9 Canadians travelled jobs on the other side of the Atlantic.

As the result of some promotional work, Canadian dustry agreed to contribute to a fund to assist Cana- an students with their travelling expenses, while par- cipating in this exchange plan. As a result the number Canadian students taking part in 1957 should be nsiderably larger. It does not require much imagina- on to see the far-reaching beneficial effects of these change visits.

FILMS

The Institute is continuing in its policy of adding owly to its library of films, concentrating on quality ther than quantity. During the year purchase was ade, to good advantage, of a copy of an excellent w mechanical engineering film on automation from e series called "The Search". This picture was first own to an E.I.C. audience during the 1956 Annual eeting in Montreal. It received an enthusiastic re- ponse then, and many times later.

Demand for the use of the Leonardo Da Vinci lm continued throughout the year, and comments on s excellence are still being received from first time ewers.

ANNUAL MEETING

Mention should be made of the fact that the 1956 nnual Meeting, in Montreal, was the largest in In- titute history. Some of those present, including a num- er of the old-timers with many meetings in their ex- erience, also ventured the opinion that it was the ost successful. The technical program, of high calibre roughout, consisted of 33 papers and 2 panel dis- ssions. A total registration of around 1700 gave the eeting an undisputed claim to the greatest in size, and the rest must be left to the appraisal of those who were there.

A new feature of the meeting was the introduction of an exhibition of engineering photographs. Industrial firms across Canada, and others such as consulting engineers, were invited to submit photos of engineering work and development of all kinds with which they had been associated in the previous year. The response was excellent. The collection of mounted prints so obtained, having become the Institute's property, is being shown elsewhere now, to university engineering societies and to other interested groups. It is planned to continue this project on an annual basis.

LIFE MEMBERS

The growing fraternity of Life Members of the Institute continued to maintain a lively interest in its affairs throughout the year. One regular and several informal meetings of their own were held, out of which came the decision to collect and donate sufficient funds to purchase another film for Institute use. The life members are now the principal support of our film activity.

More detailed information concerning this senior group of members will be found in a following section of this report, as submitted by their secretary.

INSTITUTE INSIGNIA

Another item of interest during the year, which reached quite unexpected proportions, was the introduction of the new Institute slide-rule tie clip. It was devised in the shape and appearance of a tiny slide-rule, with an "E.I.C." monogram taking the place of the cursor. Council ruled that it be given free to all new student members, sold to Members and Juniors at $2.00, and to existing Students at $1.00. The results have been beyond the most enthusiastic expectations. The clip was an instant success, and at time of writing the distribution is in its third thousand. If you want one, consult your branch secretary, or write Headquarters.

THE OTHER REPORTS

This portion of the annual report is supplemented, as usual, by those of the various committees and departments of Headquarters. They have been prepared for your information, and members are urged to read them as they continue their examination of this overall report. Only in this way can a real knowledge of the year's accomplishments be obtained.

ROLL OF THE INSTITUTE

The membership of all classifications now totals 16,580. New names added for the year amount to 1,684, but deaths, resignations and removals amounted to 1,174, making a net gain of 510.

During the year 1,610 candidates were elected. These were classified as follows: Members 276, Juniors 73, Students 1,260, Affiliate 1. Seventy-four reinstatements were effected. Life Membership was conferred on seventy-eight members under by-law 26.

Transfers from one grade to another were as follows: Junior to Member 140, Student to Junior 601, a total of 741.

Removals From The Roll

There have been removed from the roll during the year by resignation and for non-payment of fees: Mem-been little, if any, activity on this matter in Canada, but it has been noted that there is a gradual increase in the number of engineers joining unions in the United States. A recent report entitled "Unionization Among American Engineers", published by the National Industrial Conference Board, gives very complete data on this subject.

Late in the year, this Committee was requested to prepare for the development of a co-operative agreement with the professional engineers of Prince Edward Island. This matter is now in the preliminary stages and will be carried on with during the coming year.

E. B. Jubien, M.E.I.C.
Chairman

CANADIAN CHAMBER OF COMMERCE

As the representative of The Engineering Institute of Canada on the Executive Council of The Canadian Chamber of Commerce, I would like to report as follows.

As Canada's national business organization, representative of all types and sizes of business, The Canadian Chamber of Commerce develops policies on national economic matters which are presented to the Federal Government each year following the Chamber's annual meeting. Support of the system of freedom of enterprise is, of course, the central core of the Canadian Chamber's policies, and I thought you might be interested in having the Chamber's official views on subjects which are of particular interest to the engineering profession.

On trade, the Chamber, among other things, recognizes that certain segments of the Canadian economy are seriously affected by competition from foreign sources and asks the government "without deviating from the principles of GATT": *(a)* to exercise closer control over tariff classifications of imports *(b)* to investigate promptly imports suspected of evading dumping duty and *(c)* to strengthen regulations to prevent imports at dump prices.

On immigration, the Chamber reiterates its long-standing policy that Canada should aim for a population of 30 million by 1975, and warns that unless there is a marked increase in the number of immigrants, Canada is likely to fall far short of this goal. To increase the flow of newcomers, the Chamber recommends, among other things, a more active program of publicity to ensure that a true picture of Canada and Canadian opportunities is kept at all times before source countries and immediate steps taken to establish an organized program to encourage more immigration from the United States.

On public finance and taxation, the Chamber expresses the belief that both personal and corporate income tax rates are still too high for a developing country. It also asks the government to scrutinize ordinary peace-time expenditures carefully with a view to keeping them to a minimum consistent with meeting recognized public objectives and to ensuring value for the money expended and also examine with care the costs of our continuing defence establishment.

On national defence, the government is urged not to relax Canada's defence program, and to formulate and publicize as widely as possible a clear policy with respect to the Canadian militia and the reserves of the navy and air force.

On a national highway program, the Chamber urges federal appropriations be made available on an equitable basis to the various provinces for use in the improvement of Canada's main highway network. Authority over administration of road projects should remain under provincial highway departments.

On national harbours, the Chamber urges the government to take under control and assume responsibility for the necessary capital outlay of key ports in order to develop those ports scientifically to the ultimate advantage of the whole nation.

On Trans-Continental Airline Services, the Chambe asks the government to permit establishment of othe trans-continental airline services within Canada.

On radio and television, the Chamber asks th government to establish a separate regulatory bod having minimum essential regulatory powers over radi and TV broadcasting in Canada. The Chamber als asks that TV licenses be granted to citizens who desi to establish additional stations in centres at prese served by the C.B.C. or private stations, provided alte native channels are available, and that the C.B.C. b required to seek an annual grant from Parliament f any public funds requested to operate C.B.C.

On natural resources, the Chamber urges upon i members the promotion of Federal, Provincial ar business policies which will lead to the properly i tegrated development of Canada's natural resources the interest of the nation as a whole. The Chamb stresses the importance of government policies in r source management which will ensure maintenanc and, where possible, expansion of all renewable r sources, and calls upon its members to advocate a support such policies.

F. G. Rutley, M.E.I.C.
Institute Representative

CANADIAN STANDARDS ASSOCIATION

Late in the calendar year the headquarters office w moved from the National Research Council Buildi to 235 Montreal Road, Ottawa 2. Also during the ye the name by which the Approvals Division Labo tories outside Toronto have been known was chang to C.S.A. Testing Laboratories, and the service p vided has now been styled "certification service", wh replaces the earlier name "approvals service".

The Welding Bureau continues to operate succe fully and is extending its field to cover various n activities in the welding world. Considerable progr has been made in the preparation of a code for mar welding, and a new standard specification is under v for "resistance or flash-butt" welding.

The educational services of the Bureau are be particularly well-received throughout the industry a new courses are continually being developed a offered to those interested. The fundamental cou has met with very favourable comment in the Uni States and arrangements for the sale of copyrights legalize publication and use in that country are alre effective and are likely to be extended.

The general manager of the Bureau is schedu to deliver a technical paper describing this edu tional work at the Congress of the International Insti of Welding in Germany, and at the Commonwealth Welding Conference in England during next summer.

Certification of plants in Canada is constantly growing, and at the C.S.A. directors' meeting in December, the number of firms so certified was recorded as 201.

The Approvals Division have maintained a high rate of progress and are financially able to reduce their indebtedness, which was incurred at the building of their new Etobicoke laboratories. The question of licences and standard marks has been much in evidence in recent months and new procedures are now being established.

Many meetings of technical committees have been held during the year, at least 45 being recorded, while the directors have assembled five times as a board, apart from sessions of the executive and special sub-committee.

New standard specifications, to the number of 35, have been issued: 15 in the electrical field, several for car iron parts and practices, and others for such diverse matters as masonry cement, binding head screws, fire fighting apparatus, pole line hardware, copper tubing, wooden sash frames, pest control chemicals (names).

Further, standard specifications in varying stages of development number 121, and completely new projects have been authorized on construction plywood, rubber tiles, radiation danger markers, etc.

Internationally, C.S.A. has increased somewhat its participation in I.S.O. Committee work, and has enlarged its responsibilities within the I.E.C., which it represents in Canada.

P. L. Pratley, M.E.I.C.
Institute Representative

LEGISLATION COMMITTEE

No matters have been brought before your committee, but inasmuch as the "Terms of Reference" are not altogether clear, your committee has formally requested clarification.

At the Council meeting in Montreal on December 8th the president suggested that your committee submit suggestions to council as to what the terms of reference should be. Your committee will study this matter and report at a later date.

C. G. Kingsmill, M.E.I.C.
Chairman

COMMITTEE ON PRAIRIE WATER PROBLEMS

Although water still remains a very active subject on the prairies, and your Committee has been watching the problems associated with its utilization, there seemed no vital matters under discussion this year to warrant a meeting of the Committee.

The most interesting progress made this year was the decision of the P.F.R.A. to let contracts and proceed with the construction of the diversions of the Belly and Waterton Rivers into the St. Mary's reservoir. This work is now proceeding after many years of discussion with the United States and the International Joint Commission, as a fair percentage of the water being diverted is of United States origin.

No new irrigation developments are in prospect but the further development of the St. Mary's—Milk River system bought additional acres under irrigation. P.F.R.A. have continued their program of reconstruction, rehabilitation and extension of the Bow River system (formerly the Canada Land and Irrigation) with the object of bringing more acres under irrigation.

G. A. Gaherty, M.E.I.C.
Chairman

PAPERS COMMITTEE

Continuing in the pattern established over the last several years, the committee worked in co-operation with headquarters staff arranging for suitable papers for presentation at the 71st annual general and professional meeting of the Institute to be held at Banff, Alberta, in June of this year.

Suggestions for papers and offers to write them came in from several sources, i.e. directly from members of the Institute, from the various members of the Papers Committee, from branches, and from headquarters staff. In all, about 50 items were screened and considered.

Because the 1957 annual meeting is scheduled to take place in Banff, the committee followed the usual rule of selecting a fair proportion of papers of western origin and of particular interest to members from that part of Canada. In this connection the program will include a total of nine papers on subjects associated with the petroleum industry and this will accent the technical part of the meeting. In commenting on the work of the committee special mention should be made of the help provided by several out-of-town members, in particular G. W. Govier, M.E.I.C. of Edmonton, T. F. Hadwin, M.E.I.C. of Vancouver, W. B. Pennock, M.E.I.C. of Ottawa, and Fred L. Perry, M.E.I.C. of Calgary.

The committee met five times between October 22, 1956, and January 10, 1957, making its report to Council on January 22, 1957. In this report a program of 33 papers and one panel discussion was recommended. This recommendation was approved by Council at its Quebec meeting on January 26, 1957.

In addition to the foregoing work the committee was given another task by Council. They were asked to study and report upon the feasibility of establishing a panel of travelling speakers to assist in branch meetings. The survey of branches and the resulting report were undertaken by the Papers Committee chairman and, with the consent of the committee, he presented this report to Council also at its meeting on January 26, 1957.

W. H. Gauvin, M.E.I.C.
Chairman

PUBLICATION COMMITTEE

Production of *The Engineering Journal* in 1956, the thirty-eighth year of its publication, showed the highest figures so far. Some 207,000 copies were printed, and the average monthly circulation was 16,909. Reading material averaged 100 pages a month, of which 34 per cent represented technical papers. As in previous years there was more reading material than advertising space, in the ratio 51:49. (In Canadian trade journals, generally, there is a much greater volume of advertising than of reading material.)

The 60 papers published in the technical section covered a wide range of some 39 different subjects or industries. Some papers dealt with more than one engineering field and are not readily classified, but a more detailed analysis is given here.

Category	% total papers	% total pages
Civil	33.9	35.8
Mechanical	23.7	26.1
Electrical	18.7	18.2
Other branches*	23.7	19.9

*Including chemical, petroleum, pulp and paper, etc.

The committee wishes to record their thanks and appreciation to all authors, correspondents, and advertisers.

Continued and growing interest in the technical papers is shown by more extensive written discussion of papers and the total of 20,350 reprints ordered during the year.

Apart from papers from the annual meeting and direct contributions from members and other authors, over fifty requests were made to industry and other organizations for technical articles on specific subjects covering many fields of interest to the engineering profession. This policy is being carried on, and it is anticipated that further good material will continue to be received as a result.

Starting with the July issue, printing of the *Journal* was transferred to Hugh C. MacLean Publications Limited, in Toronto, for economic reasons. Good working liaison was quickly established and the new printer is now, in general, giving very good service.

The opportunity was also taken to revise the style and content of the *Journal* to the extent of improving the clarity of the typography and re-arranging the editorial content. This included the introduction of a new section, Canadian Developments, to give news and reports on major engineering developments in Canada, including the progress of the St. Lawrence seaway and power project. The Abstracts section was extended to cover news of engineering interest as well as material from engineering literature; some 96 items were published in the year.

A new series of articles on engineering careers in Canada, intended particularly for the guidance of the young engineer, was started in January and will continue into 1957.

The readership survey was re-introduced in October and is to be extended over a twelve-month period. Initial returns were around 40 per cent.

The gross average cost of production was $15,410 per issue, which represents 88c per copy printed or $10.56 per year per subscriber.

The committee submitted a report to Council recommending the publication of separate issues of *Transactions*, to include papers of technical interest. Although this was considered in January 1957, the committee is pleased to report that Council has approved such publication and action has been taken for the preparation of the first issue of *Transactions*.

The five meetings held during the year were well attended by committee members and by headquarters staff.

G. N. Martin, M.E.I.C.
Chairman

LIBRARY REPORT 1956

Commencing January 1, members were no longer r quired to make a deposit before borrowing books fro the library. Letters were sent to the nine hundr members having deposits informing them of the chan in this regulation which had been in effect since t opening of the library. One hundred and sixty-t members requested the return of their deposits, o hundred and twenty-two communicated with the libra agreeing to donate their deposits in recognition of s vices rendered, and no word was received from t remainder, who thus indicated their willingness to lea their deposits. The generosity of these members greatly appreciated. The three thousand eight hundr dollars remaining are to be used for the purchase books and other equipment. There are now five h dred active borrowers registered, whereas many of t nine hundred previously listed had not used the libr for several years.

Another change in the regulations affected memb living out of town who are no longer asked to p postage as the Institute has obtained permission fr the postal authorities to use the special book r available to libraries.

Equipment purchased during the year include book truck, new lights in the reading room stacks new card system for recording the receipt of periodic and a photostat machine. This latter is proving use especially for copying articles in bound periodic Members are sold copies at cost.

During the year the library staff handled s twenty-five enquiries a day many of which were ceived over the telephone and by mail. A pampl was mailed to all members outlining the services p vided by the library.

Five hundred books were added to the collect four hundred of which, valued at $3000, were review in *The Engineering Journal*.

During the summer the books in the reading r were re-shelved and much obsolete material discar Re-organization of the periodical stacks in the lo floor was commenced, and duplicate and unwa material sold. It is expected that this task will completed during 1957.

The increased use made of the library throug the year is encouraging, and it is hoped that in 1 the staff will be able to provide even better ser

(Miss) Shirley Cour
Librari

EMPLOYMENT SERVICE

It can be stated truly that the employment de ment of The Engineering Institute has become al an international contact for those seeking inform about Canada. Letters acknowledged by the de ment numbered approximately 2,000. They cover variety of subjects, ranging from job listings, co living, and the housing situation, to the validit educational certificates and other qualifications. marks bore such names as Turkey, China, Africa, S America, countries in Europe, and all parts of United Kingdom. During the later months of the enquiries from the U.K. increased, and it is antici that Canadian employers can rely on this sour engineer manpower, at least for the near future, to an even larger extent than was experienced during the past year.

A drastic shortage of engineering personnel was noted during 1956. Approximately 500 jobs were advertised through the employment pages of *The Engineering Journal* and the employment bulletin. As was previously reported, the department was forced to rely on its advertising facilities to bring the right contact to the employer seeking personnel with specialized technical experience.

A number of large American employers approached the department. In accordance with the Institute policy, it was necessary to restrict the services to Canadian employers, or to those others seeking engineers for work in Canada.

Contrary to previous years, the department accepted a number of advertisements from U.K. personnel seeking contacts in Canada. Most applicants had made definite plans for emigration and had acceptable qualifications for eventual membership in the Institute. The response from employers was gratifying and this service will be extended during the coming year.

During the month of February employers were contacted, suggesting that they list their needs for undergraduates. Many successful placements were made. However, it was most evident that more positions were available than possible candidates. This part of the department's work is now well established and is known to many young men across Canada. The fact still remains, however, that it is difficult to arouse the interest of an employer when the applicant is not easily available for interview.

The employment service was represented for the first time at the annual meeting in Montreal. The office in the Mount Royal Hotel was visited by 41 employers and many engineers.

The employment service is anxious to extend its usefulness to the membership. Enquiries are therefore invited, in an endeavour to enlarge and improve this service.

(Miss) A. Summers
Employment Service

FINANCE COMMITTEE

The Finance Committee met eight times during the year. At these meetings the financial affairs of the Institute were reviewed and appropriate action taken. The final results are evident in the financial statement and the Treasurer's report.

It is also the function of this Committee to review all resignations, removals from the list of members, requests for special consideration and reinstatement of membership. In so doing over 1100 cases were considered.

In 1956 operating budget was received and approved early in the year, and re-studied at the half year.

Consideration was also given to proposals for expenditures outside of the budget, and recommendation made to Council.

Some of such proposals were the publication of biographies of prominent Canadian engineers, grants for professional development courses at Branches, allocation of funds for the maintenance of representatives at engineering degree-granting universities and the recommendation that funds be made available for the publication of *Transactions* to the extent of $2,500.

The investment portfolio was currently under review; reserve funds were invested as they became available.

During the year the chairman convened an unofficial gathering of available current and past presidents and vice-presidents to consider Institute development. From this meeting there has resulted the approval by Council for the formation of a policy committee.

Appreciation is expressed by this committee to the general secretary and his staff who have given every cooperation and assistance in carrying out this phase of the Institute's activities.

R. L. Dunsmore, M.E.I.C.
Chairman

The annual comparative statements of revenue and expenditure, and of assets and liabilities, are presented on pages 10 and 11.

TREASURER'S REPORT

Your Treasurer is happy to report that at the close of another fiscal year the finances of the Institute are again in a very satisfactory condition.

In the year 1956, revenues exceeded $535,000 and were the highest in our history. Expenditures on ordinary account were less than anticipated; consequently it was possible to increase the allocation to reserve funds and still show a surplus of more than $7500 in the overall results of the year, which is comparable to the surplus for the preceding year.

Your attention is drawn to the fact that income from investments for 1956 amounted to nearly $8000, approximately twice the sum realized from this source in 1955.

This result reflects the wisdom of the decision taken in 1955 to increase the portfolio of investments held by the Institute.

R. A. Emerson, M.E.I.C.
Treasurer

LIBRARY AND HOUSE COMMITTEE

Considerable work was carried out during the year 1955 in preparation for the annual general meeting. Consequently, this committee was relatively inactive during the year 1956.

The Montreal Branch elicited interest in making a contribution towards the improvement of the Headquarters auditorium facilities. Discussions were held with members of the Library and House Committee. A number of needed improvements were identified. The Montreal Branch elected to contribute a slide projector.

(Continued on page 12)

Comparative Statement of

Revenue and Expenditure

Year ended December 31

REVENUE

	1956	1955
Membership Fees:		
Arrears	$ 7,827.34	$ 8,124.25
Current*	188,938.88	183,092.09
Advance	3,348.76	860.27
Entrance	3,132.58	2,428.46
	$203,247.56	$194,505.07
Publications:		
Journal sales	2,899.61	3,306.55
Journal advertising	318,730.73	290,769.29
	$321,630.34	$294,075.84
Income from Investments	7,994.61	4,152.35
Refund of Hall Expense	2,988.50	3,863.50
Sundry Revenue	58.91	223.47
	$535,919.92	$496,820.23

*Membership fees include *Journal* subscriptions.

EXPENDITURE

	1956	1955
Building Expense:		
Property and water taxes	$ 2,588.80	$ 2,560.7
Fuel	1,021.33	1,153.0
Insurance	646.52	627.5
Light, gas and power	789.50	797.5
Caretaker's wages and services	2,100.00	1,924.7
Maintenance, alterations and repairs	3,035.44	1,810.4
	$ 10,181.59	$ 8,873.[illegible]
Publications:		
Salaries	38,695.03	32,717.[illegible]
Printing and sundry expense	150,298.63	150,454.4
Advertising commission	79,690.60	72,664.[illegible]
	$268,684.26	$255,836.[illegible]
Office Expense:		
Salaries	83,633.11	81,773.[illegible]
Telegrams and postage	5,115.99	4,521.[illegible]
Telephones	1,899.80	1,798.[illegible]
Office supplies and stationery	9,676.66	8,993.[illegible]
Audit and legal fees	940.00	620.[illegible]
Miscellaneous expense	5,090.16	5,386.[illegible]
Depreciation—furniture and fixtures	1,488.43	1,442.[illegible]
	$107,844.15	$104,534.[illegible]
General Expense:		
Students' and education conference	6,619.43	1,048.[illegible]
Council and annual meetings	4,804.21	6,474.[illegible]
Travelling	5,904.88	7,781.[illegible]
Institute prizes	442.85	567.[illegible]
Library salary and expense	13,008.96	10,892.[illegible]
Interest, discount and exchange	1,182.25	845.[illegible]
Committee expenses	1,360.40	1,533.[illegible]
Cost of membership in other societies	4,364.67	2,797.[illegible]
Sundry expense	5,091.59	4,606.[illegible]
Pension plan	2,700.41	4,623.[illegible]
	$ 45,479.65	$ 41,171.[illegible]
Rebates to Branches	28,158.73	27,423.[illegible]
Total Expenditure	$460,348.38	$437,839.[illegible]
Transferred to Reserve Funds:		
Building	47,000.00	27,000.[illegible]
Pension fund	10,000.00	10,000.[illegible]
Contingencies	7,000.00	5,000.[illegible]
Publications	3,000.00	8,035.[illegible]
Reserved for Bad Debts	1,000.00	1,000.[illegible]
Surplus for Year Transferred to Surplus Account	7,571.54	7,944.[illegible]
	$535,919.92	$496,820.[illegible]

Comparative Statement of

Assets and Liabilities

December 31

ASSETS

		1956	1955
urrent Assets:			
Cash on hand and in banks.........		$ 8,952.99	$ 21,917.65
Accounts receivable—less reserve....		26,134.88	24,483.94
Arrears of fees—estimated.........		3,500.00	3,500.00
		$ 38,587.87	$ 49,901.59
vestments—at Cost:			
Property of The Engineering Institute of Canada.....................		261,516.74	171,731.61
Property of special funds account—see contra.....................		21,046.56	20,644.19
(Approximate market value $276,742.00)			
undry Advances..................		650.00	650.00
eposit with Postmaster..........		570.00	500.00
repaid Insurance, Etc............		1,750.00	296.94
ibrary—nominal value............		1.00	1.00
urniture and Fixtures			
—at cost..............	$37,983.61		
less depreciation........	24,587.70		
		13,395.91	12,982.77
and and Buildings...............		36,000.00	36,000.00
		$373,518.08	$292,708.10

LIABILITIES

		1956	1955
Current Liabilities:			
Accounts payable.................		$ 22,190.44	$ 16,354.37
		$ 22,190.44	$ 16,354.37
Special Funds:			
As per statement attached.........		21,046.56	20,644.19
Reserve Funds:			
Building.........................		154,000.00	107,000.00
Building maintenance.............		1,500.00	1,500.00
Pension fund.....................		40,366.50	30,366.50
Contingencies....................		25,000.00	18,000.00
Publications.....................		25,000.00	22,000.00
Surplus Account:			
Balance as of December 31, 1955.............	$76,843.04		
Plus surplus for year as per statement attached	$ 7,571.54		
		84,414.58	76,843.04
		$373,518.08	$292,708.10

AUDITOR'S CERTIFICATE

We have examined the statement of assets and liabilities of the Engineering Institute of Canada as of December 31, 1956 and the atement of revenue and expenditure for the year ended on that date and have obtained all the information and explanations we ive required. Our examination included a general review of the accounting procedures and such tests of accounting records and other ipporting evidence as we considered necessary in the circumstances.

In our opinion the above statement of assets and liabilities and accompanying statement of revenue and expenditure are properly rawn up so as to exhibit a true and correct view of the state of the affairs of the Institute at December 31, 1956 and the results of its perations for the year ended on that date, according to the best of our information and the explanations given to us and as shown by he books of the Institute.

PEAT, MARWICK, MITCHELL & CO.,
Chartered Accountants.

Iontreal, Quebec, February 11, 1957.

This very handsome addition to the auditorium facilities has now been in service for some weeks and is indeed appreciated.

C. E. Frost, M.E.I.C.
Chairman

Ontario Division

A statutory meeting of the Ontario Division was held at the Royal York Hotel, Toronto, on January 28th, 1956; five branches were represented by the fifteen members who attended this meeting. Present: Chairman, Dr. A. E. Berry, Toronto; J. A. Vance, Woodstock; L. F. Grant, H. G. Conn, Kingston; D. D. C. McGeachy, D. J. Bird, London; R. A. McGeachy, G. R. Henderson, Sarnia; E. A. Cross, L. F. Bresolin, M. McMurray, W. H. Peterson, C. D. Carruthers, D. D. Whitson, G. H. Rogers, Toronto.

Discussion at this meeting stressed the earnest desire of the Ontario Branches to advance confederation and it was the general opinion of the members present that it offers definite advantages to all members of the profession in Ontario.

The following three members were nominated and duly elected to the board of management for 1956: P. E. Buss, Thorold; H. G. Conn, Kingston; M. A. Montgomery, Kitchener.

The Chairman appointed C. Carruthers, E. A. Cross and J. F. MacLaren as a nominating committee to prepare, a slate of officers for distribution of ballot.

The following change was proposed in By-Laws: Amend Sec. 4 (a) to read "The Chairman and Secretary, or duly appointed alternate, of each Ontario Branch". The proposed change was left in the hands of the Chairman and Secretary for circulation to the Branches for consideration and approval.

It will be of interest to note that the name of the Division's chairman, Dr. A. E. Berry, was included on the recently published list of Life Members, and the members expressed appreciation of his valuable services to the E.I.C. in many activities during his membership.

G. H. Rogers, M.E.I.C.
Secretary

Reports from the Branches

FOLLOWING ARE the reports received from the Branches of the Institute on their activities during the year 1956. Membership and financial statements on page 28.

Amherst

Six meetings were held during the year 1956.

In February a supper meeting was held and general business was discussed.

At the March meeting Mr. R. Alexander gave a very informative talk on the effects of the January sleet storm on his company's electrical equipment.

At the April meeting Mr. J. Wilson showed a very interesting film on the Quebec North Shore Railway from Sept Isles to Knob Lake and spoke on drainage problems involved.

Mr. J. W. Byers also showed an interesting film on the Shepody Dam.

On June 1, the Branch held its annual meeting at the Amherst Hotel and the new executive was appointed with R. Alexander as chairman; J. Wilson, vice-chairman; W. G. Miller, secretary-treasurer; and G. C. L. McEnery, R. Miner, and J. W. Byers as the executive committee.

In September, Amherst was honoured by a visit from the president, Mr. V. A. McKillop, and Dr. L. Austin Wright, general secretary.

In October five carloads of members and their wives motored to visit Shepody Dam and enjoyed dinner in Moncton on the return trip.

Belleville

During 1956 seven meetings were held by the Belleville Branch. Among the topics covered and papers read were such subjects as "The St. Lawrence Power Development", "Digital Computers", "Silicones", and "Controlled Volume Pumping".

The February meeting was one sponsored jointly with the Bay of Quinte Section of the Institute of Radio Engineers at which a paper on transistors was read.

One plant visit was made during the year, to the Bethlehem Steel Company's Marmoraton Mine, near Marmora.

The second half of a Professional Development Course in business administration, started in the fall of 1955, was concluded during the early part of 1956. This course was under the direction of Queen's University. The second half, referred to herewith, consisted of approximately 20 lectures. An average of 50 people were enrolled with the attendance running above 90 per cent.

The Belleville Branch has agreed to assist the local high schools in screening applicants for University of Toronto bursaries in connection with students planning to enter an engineering course there. Also, along this line it should be mentioned that the Branch again sponsored a $25 prize to be given to the Grade XIII student in both of the two local high schools who plans to take an engineering course and who attains the highest standing in English, algebra, trigonometry, geometry, physics and chemistry. This year the prize was won by Kurt Pieper.

Border Cities

During the year the Branch has met nine times and eight executive meetings have been held.

The regular meetings of the Branch were as follows: January 19. "Problems in the design of nuclear power reactors", by R. C. Johnston, of the Canadian General Electric Company. February 23. Dinner meeting: "Traffic Problems" by Eric Wiley, traffic co-ordinator for the City of Windsor. March 22. Tour of Great Lakes steel plant, Ecorse, Michigan, arranged by H. Lewis, public relations director. April 19. "The Investment Industry" by Jack Stodgell of S. J. Stodgell and Company. May 17. Tour of Chrysler Corporation, plant 3; address by Jarman Craig, vice-president, personnel. Sept. 13. Tour of H. J. Heinz Company of Canada Ltd., Leamington, Ont. October 26. Annual Engineers' Dinner Dance, Prince Edward Hotel Ballroom. November 15. Dinner meeting and film night; film: Job 99—Pluto. December 6. Annual meeting; film night at Prince Edward Hotel; election of officers.

Executive meetings were held in the offices of the Canadian Bridge Company on eight occasions.

The Ladies' Auxiliary has had a successful year in promoting friendship among the members. Their activities included weekly bowling, two bridge groups, one meeting every second week in the evening and the other once a month in the afternoon. A public speaking class was also held twice a month. The ladies also accompanied the Branch members on plant tours during May and September, and joined us for the annual engineers' dinner dance in October.

Calgary

During 1956, ten general meetings were held, including a tour through Imperial Oil producing department's technical service laboratories.

The annual "slide rule soiree" was held in February and once again was an outstanding success, with about 340 in attendance. The floor show put on by the members and their wives was one of the best yet.

The regular Monday luncheon meetings have remained very popular, having an attendance of from 50 to 60 members.

In the spring, a students' night was held at Western

Canada High School. A panel of six members representing the various branches of engineering addressed the students, after which a question and answer period followed. The students were keenly interested and the executive felt that this was a most successful evening.

No professional development courses were undertaken in 1956 but a series of meetings along these lines have been arranged for 1957.

Engineers' Wives' Association: As a prelude to the opening of the season, the executive was entertained at luncheon by our president, Mrs. K. W. Mitchell. Plans for the coming year's activities were discussed. All our groups, "ladies and mixed bridge" "handicraft" and "bowling" function well and enthusiasm is high.

Before our own activities got under way the E.I.C. invited us to an outdoor barbecue, which was most successful—and we hope will become an annual affair. Some of our members worked with the executive of the Men's Club and assisted in many ways.

Our annual membership tea, held this year at the Palliser Hotel on September 12th was an outstanding success, there being 149 members and 11 guests.

We entertained our husbands at a "Pot Luck" supper on October 25th in the Rosedale Community Hall. Delicious food, dancing and a bit of a floor show put on by some of our local talents, with that indispensable aid of the men, completed the evening's entertainment.

Cape Breton

There were ten gatherings in 1956, seven of which were regular dinner meetings held in the Isle Royale Hotel in Sydney, two were business meetings held in the Reserve Army Engineers Corps headquarters in Sydney and one was an informal dance held in the ballroom of the Isle Royale Hotel.

We regretted that President McKillop's visit to our Branch, early in September, was not as well attended as we would have wished. A majority of our members were away on vacation and others found the visit to be somewhat early in the season. Those who attended certainly enjoyed hearing Mr. McKillop and were only sorry that others of our membership were not present to hear him speak.

In January, Mr. M. R. Campbell, our immediate past Branch Chairman, spoke commendably on a recent trip he made to Germany in connection with their steelmaking practice. In February, we took time off from business and entertained the ladies at an informal dance at the Isle Royale Hotel. Comments on the Leonardo Da Vinci film shown in March were most laudatory. Again in March, the Branch met at the Reserve Army Engineers Corps quarters in Sydney and held a business meeting, which resulted in the drafting of a set of Branch by-laws. In April, Captain Mahar of Army Intelligence spoke on Middle Eastern affairs. In the light of present developments in Egypt and Israel, this was indeed a most informative topic. Oxygen in the steelmaking industry was the topic for our meeting in May. Our lobster party in June was by far the best to date. Good weather, a plentiful supply of lobsters and hearty appetites were all contributing factors to a very enjoyable evening. We are indebted to Mr. M. R. Campbell for the use of his summer home as the locale for our party.

For our November meeting, we had a speaker from Canadian General Electric on recent developments in gas and steam turbines.

At our annual business meeting in December, the members felt that 1956 was a very successful year in the Branch. Hopes were expressed that 1957 would be as active and enjoyable.

Corner Brook *(see page 27)*

Cornwall

Programme Committee: We have tried to maintain the varied programme of the previous year, and have, to a certain extent, succeeded. We had speakers on foundry practice, atomic power generation, town planning, plastics in industry, Duke of Edinburgh's conference, and a plant visit. In addition to these we had a very successful president's visit in February and another visit from the president to present our bursary in December.

We are, this year for the first time, running our programme from September to June. We find this attains far more continuity from executive to executive.

Average attendance for the year was thirty.

Membership Committee: The membership of the Cornwall Branch increased by eleven, from sixty-seven to seventy-eight, mainly due to an influx of engineers for the Hydro development in the Cornwall area. The Cornwall Branch is pleased to record that the Hydro engineers take an active part in Branch affairs and have arranged and conducted a number of tours for visitors to the Branch, such as the president of the Engineering Institute.

Bursary Committee: In 1956, the Magwood bursar[y] was established, and the first recipients chosen. Th[e] funds for this bursary are provided by local industrie[s] The first two recipients are brothers, Kent and Donal[d] Plumley, who are now attending Queen's Universit[y] This bursary is for $1200, and it is hoped to provid[e] these funds annually.

Eastern Townships

Branch activities for the year 1956 may be summariz[ed] as follows: January 15. Mr. H. T. Immerman, vic[e] president and chief engineer of Spencer, White [&] Prentis, engineering consultants, of New York City, [on] "The Practical Design of Foundations"; approximate[ly] 65 persons present, for the dinner meeting. Februa[ry] 10. Messrs. H. Little and L. S. Merrill, of R. & [M.] Bearings, presented two films on bearings "Engineeri[ng] to the *n*th Degree" and "Engineering on the Bal[l]" 30 persons present at the dinner meeting. March [..] Mr. J. O. Eby, mine manager, Canadian Johns-Manvil[le] on "Some Methods of Mining"; some 40 persons w[ere] present. April 12. Dr. B. G. Ballard, director of Ra[dio] and Electronics Division, National Research Council, [on] "Research and the Engineer"; close to 70 pers[ons] attended this dinner meeting. June 2. Annual elect[ion] meeting at the Hillcrest Lodge. This was at the sa[me] time a joint meeting with the members of the Corp[ora]tion of Professional Engineers of the Province of Queb[ec] at which ladies were present; some 110 persons atte[nd]ed. October 6. Inaugural meeting; golf tournam[ent] held at the Sherbrooke Country Club; some 42 pers[ons] attended the ensuing dinner and dance. November [..]

oint meeting of the E.I.C. and of the CPEQ where he present president of the Corporation, Mr. Leo oy, talked on the role of the Corporation; some 70 ersons attended the dinner meeting. December 14. Ir. R. D. Mawhood, of C.G.E., presented two films: Power and Passage" about the St. Lawrence Seaway; ome 35 persons attended the film showing.

Edmonton

This Branch held eight dinner meetings during 1956 with an average attendance of 66. The two highlights f the year were the annual picnic and the annual anquet and dance. Both of these functions had an ttendance of over 300.

This Branch did not have a professional developent course and did not carry out counselling in High chool during 1956.

The Engineers' Wives' Club was very active during 956.

Engineers' Wives' Club: The membership at the end f 1955-56 season was 215. The new season to date hows a membership of 205. Included in the club ctivities are six different groups, the handicraft group, fternoon bridge, evening mixed bridge, junior mixed ridge, book reviews and bowling, all of which are oing very well.

During the year the social activities have been as ollows: January. The annual cocktail party, husbands ncluded. February. An oriental dinner; Prof. L. E. Gads, of the Engineering College of the University of Alberta, gave a very humorous talk on "European Observations". March. An Italian dinner, entertainment provided by a musical variety show and an art display y Janet Churchill. April. A dinner and the annual usiness meeting. September. The membership tea. November. A dinner honouring Mrs. McKillop, wife of he E.I.C. president; "Women and the History of Edmonton" was the subject of a talk given by Elsie Park Gowan. December. A general meeting; Peggi Adams poke on "Grooming and your Personality". Refreshments were served at the conclusion of the meeting.

Fredericton

A total of nine general meetings were held, with attendance varying between 30 and 125.

Two of the meetings had special significance for the student members at the University of New Brunswick. One of these was a joint dance held in the Lord Beaverbrook Hotel ballroom and the other was a smoker or the graduates in May.

A joint meeting was held with the local section of he Military Engineers' Association of Canada in the Headquarters Officers' Mess, at which time Mr. Lorne Wiggs, of Wiggs, Walford, Frost and Lindsay, addressed the gathering on the heating plant and distribution system at Camp Gagetown.

The annual meeting held "up-river" to afford the non resident members a better chance to join in activities, took place at the Beechwood power development on the Saint John River. Other guests at this meeting included the Maine section of the American Society of Civil Engineers and the Engineer officers rom Loring Air Force Base, Limestone, Maine.

Much effort was expended in regard to the showing of the Leonardo Da Vinci film, with a private showing for members, influential and well known citizens and teachers. However, the film was released to television in this area less than a week before our public showing which resulted in very poor attendance and a net loss on operations.

The Professional Development section was dropped this year as it was found that the usual type of meeting in a relatively small centre would not sustain attendance and ideas to instill new blood and vigour found to be impracticable or beyond our scope.

Halifax

The past year has been a very successful one for the Halifax Branch. We have held some very interesting meetings, such as with the Military Engineers and the one at Stadacona. We have also held some very interesting and informative visits, one to the National Research Establishment and another to the Imperial Oil Refinery.

The presidential visit was a great pleasure to us and we hope the visitors enjoyed their stay in our city.

Looking to the coming year, we have quite a number of proposed meetings and visits lined up.

Last May the Branch was very well represented at the annual meeting of the Institute, held in Montreal.

The panel discussion held in conjunction with the student meeting last year was very well received and it is suggested that this type of meeting be held again this year.

Hamilton

During 1956 membership has increased from 474 at December 31, 1955, to 517 at December 31, 1956. There was an increase in all member classifications.

Seven meetings and a plant tour were held during the year and were well attended, with the exception of the Students and Juniors papers' night, and the November and December dinner meetings. It appears that Hamilton Branch dinner meetings, other than the annual dinner meeting, will not be successful either technically or socially, because of small attendance. The future of the Students and Juniors papers' night is under discussion now.

The engineer's ball held in October was again well attended and financially successful, showing a surplus of $155.65.

The executive committee learned of the J. B. Nickersons' need for an outdoor railing to aid Nick in moving about, and approved the expenditure of Branch funds to provide the equipment. A railing, repairs to front walk, and new back steps were provided at a cost of $110.

Eight committees deserve special mention this year.

Students' and Juniors' papers competition committee were successful in providing an interesting Students and Juniors night, with three contestants.

The ball committee is to be congratulated for a very successful social function, enjoyed by 215 couples.

The budget committee produced a forecast which regulated our spending and produced a surplus for the year's activities.

The professional development program committee produced a very successful program attended by many students, juniors, and members, as well as by A.P.E.O. members.

The program committee arranged a very interesting and varied program of meetings and field trip and are to be congratulated for their work.

The technical sections committee are to be congratulated for their work in setting up the atomic energy lecture series with a large number of members and non-members attending.

The attendance committee are to be congratulated for operating the telephone squad and obtaining attendance estimates for meetings.

Branch news editor is to be congratulated for the excellent press, radio, and T.V. coverage, he has been successful in providing for our meetings.

We record with regret the passing of H. G. Bertram, N. L. Crosby, and E. G. Wyckoff.

Huronia

The past year proved to be very interesting, mainly due to the wide variety of subjects covered by our meetings. Two of the most interesting meetings of the year were those at which papers were presented by our own members.

The first of these was presented by B. C. Lamble M.E.I.C. on the subject of Canada's mineral resources. This talk was supported by Mr. Lamble's personal collection of minerals which attracted a great deal of attention.

The second paper was one presented by a former councillor of our Branch, Frederic Alport, on the subject of sanitation. This was of unusual interest as it covered the engineer's responsibility for the protection of the public against the many disease-producing organisms.

During the year considerable energy was directed toward the counselling of high school students. In order to make this service more widely known, all the schools in the district were again visited and plans are being made to note this service in local newspapers. This work in our Branch was headed by our chairman, R. MacKay, and assisted by H. C. Bates, F. Alport, C. Campbell, and B. C. Lamble.

To date some thought has been given to a professional development course, but since the members of this Branch are very widely spread, no concrete steps have been taken in this direction.

Kingston

The activities for the year consisted of lectures, dinners and meetings as follows: January 24, lecture at Queen's University on "Atomic Energy"; February 23, president's visit and dinner; March 13, lecture at Queen's University on "Design in welding of aluminum"; March 20, students' papers night at Queen's University; March 23, joint Kingston Metallurgical Society, Chemical Institute of Canada, and Engineering Institute supper dance; April, lecture at RCEME Officer's Mess, on "Camp Gagetown"; June 8, annual meeting, dinner and dance.

The students' papers night, in particular, turned out to be a very successful meeting. Four papers were given on this occasion on the following topics: (a) Pitting of hydraulic turbines; (b) Alcoa direct casting process of aluminum and its alloys; (c) residual stresses; and (d) free piston engines.

Kitchener

As indicated in our financial report for 1955 our activities have been rather general and we have not attempted to conduct in the Kitchener Branch professional development courses. Careful consideration has been given to such a program and our branch directors have decided against it for the time being. Contact with the high schools has been limited to speakers outlining the course of study that a student interested in engineering might take in a recognized university in Canada. With the shortage of engineers, we feel this work is becoming increasingly important.

As far as our general meetings are concerned, we have found that plant and field trips create the most interest along with good technical papers on current engineering topics such as the atomic energy plant at Chalk River, The Ontario Water Resources Commission etc. The Branch has established a pattern of meetings and it is felt that this pattern will be adhered to for some time to come. Our social functions have been most successful and our joint meetings with other technical groups in the area have been well attended. Financially speaking, the branch has been fortunate in obtaining services from industrial concerns in the area.

Kootenay

The Kootenay Branch held eight executive meeting during the year, and 13 branch meetings, which we as follows: January. Smoker, and showing of enginee ing films; guests: members of Joint Technical Societie February. Annual meeting (dinner); election of exec tive; Branch business; speaker: Mr. Stewart Graha Inspector, School District No. 11, on "Education Toda March. Junior and Affiliate Night Dinner; talks engineering topics by our Junior and Affiliate membe April. Annual business meeting dinner; discussion branch business to help brief delegates to annual me ing of E.I.C.

May. Dinner meeting; speaker: J. H. Rees, of Tri Equipment Ltd., on "Industrial Hydraulics". June. Lu cheon; speaker: Professor H. G. Conn, of Quee University, on "Engineering at Queen's Universit guests: members of Joint Technical Societies. Ju Smoker; speaker: R. R. Pierce, general manager of Corrosion Div., Pennsylvania Salt Company, on "A Proof Construction". Guests: members of Joint Techn Societies. July. Luncheon; speaker: D. L. Mord McGill University, on "The Gas Turbine".

September. Luncheon; speaker: Dean A. E. M Donald, University of Manitoba, on "Engineering the University of Manitoba"; also in September, dir meeting; speaker: R. F. Mitchell, superintendent maintenance, C & F Division, Cominco, on "Life Formosa, Hong Kong and Tokyo". October. Di meeting; speaker: E. Benson, Cominco Administra Division, on "Duke of Edinburgh Conference". Nov ber. Headquarters' visit dinner; Dr. L. Austin Wr general secretary. December. Smoker; showing of gineering films.

Our Branch meetings this year have been received by the membership and we have endeavo to keep the members informed of the business of the Institute. All our dinner meetings contained a business meeting in which we discussed Institute and Branch business.

Our annual business meeting held in April this year concentrated on Branch business in order to brief our delegates to the annual meeting held in Montreal. Councillor H. P. Hamilton, Chairman T. W. Lazenby and Mr. E. Mason attended the annual meeting.

This year, we initiated a scholarship of $50 to be presented to the student of Grade 13 who received the highest total marks in physics, chemistry and mathematics in our area, and who is continuing his studies at a recognized university. We plan to make this an annual award and to increase its value if we can manage it financially.

Our Branch was very pleased to be able to help the Institute financially this year by donating $25 to the Colonel By memorial and by forwarding $50 from the proceeds of our showing of the Leonardo Da Vinci film.

We regret to report that we did not sponsor a Professional Development course this year, but our policy has been to sponsor such a course every second year.

Through the Joint Technical Societies in our area, our branch assisted in vocational guidance to high school students and lectures to university students during the summer.

We were disappointed this year in not having the president with us, but feel that our meeting with Dr. I. Austin Wright was beneficial to us all and was a fitting event to end a successful year.

Lakehead

During the past year, there were eight regular meetings held, and one dance. To review briefly, the meetings were as follows: January. Brigadier H. W. Love, M.E.I.C., Commander, Sask. Area, gave a very interesting talk on the Alcan Road illustrated by motion pictures. February. The Engineers' Ball was held, and for the first time since the Second World War it was formal. A tremendous success and is to be repeated. March. This was the members' night and two members gave talks. Mr. W. D. Beckett spoke on professional development and Mr. John E. Rymes spoke on the new type of diesel injection pumps now entering the automotive market. April. In lieu of the president's visit, we held a ladies' night and again we had a tremendous evening. This is to become an annual affair on the years when the president does not call on us at the Lakehead. May. This was the sister profession evening, and Mr. A. W. Maloney, a well-known Lakehead lawyer, talked on automobile insurance. An excellent evening. June. Our regular and annual meeting. September. First of the year; we heard fine talks on the Ontario part of the St. Lawrence Seaway. October. A regular meeting with a very informative address on how the men who know predict the weather. As can be imagined, this was a very humorous meeting. The local Met. man for Dept. Trans. was our guest speaker. November. Change in the chairman for meetings and did not have one this month. December. This was a luncheon meeting and was a joint effort with the E.I.C. and P.Eng. A very successful meeting, and Mr. Hotchkin and Mr. Medland of the P.Eng. were our guests.

To sum up, 1956 saw many and varied meetings for all engineers here in the Lakehead and we had a good turnout. A continued good year is expected.

Lethbridge

The following is a summary of Branch activities during 1956 (figures in parentheses are average attendances). Regular meetings, three (38); special meetings, three (97); field tours, two (46); executive meetings, eight (6).

The branch did not operate a professional development course during 1956.

Highlights of 1956 were a joint meeting with the ASCE and field tour of the Malmstrom Air Force Base at Great Falls Montana; a field trip to the P.F.R.A. Bow River project and meeting at Vauxhall, Alberta, in September and a visit by Dr. Wright in November, during which he addressed a meeting of the branch.

In April some 40 members of the branch and their wives visited Great Falls, Montana. After registering, a field trip was made to the Malmstrom Air Force Base, and to the multimillion dollar storm sewer projects under construction in the city. Following the field trips members attended a joint dinner meeting with the ASCE Montana Section, North Central Branch, followed by a dance at the Meadowlark Country Club.

In September, 52 members and their wives toured the P.F.R.A. Bow River project, including the Travers Dam, and ended the tour at Vauxhall. A brief visit was made to the Vauxhall Laboratories operated jointly by the P.F.R.A. and Dominion Experimental Station, Department of Agriculture, who are carrying on extensive research concerning soils, drainage and field crops and their suitability for use under irrigation. The party then enjoyed a dinner and an address by the late Dr. L. B. Thomson, director of the P.F.R.A., Regina.

Unfortunately, the president's visit was cancelled due to the sudden death of his assistant. Plans for the meeting in November, however, were not changed as Dr. Wright was able to visit the branch and give a very informative talk concerning the Institute. Ladies were present and a social hour and dinner were held in conjunction with the meeting.

In December the excellent film "Leonardo Da Vinci" was shown, to some 83 members and their wives, following a social hour and dinner.

The annual meeting of the Professional Engineers of Alberta was held in Lethbridge in March, and E.I.C. members were invited to the noon luncheon and dinner, hence no regular meeting was held during that month.

Branch meetings were all dinner meetings, and community singing and special musical entertainment was enjoyed at each in addition to the main program. Mr. and Mrs. George Brown who have been providing dinner music and accompaniment for our meetings for over 30 years, were again able to favour the branch during 1956.

Ladies' Auxiliary—The ladies' auxiliary completed another active and interesting year. Regular monthly meetings were held, with bridge parties alternate months. Guest speakers covered a variety of interesting and educational subjects every second month.

Highlight of the year was the year-end banquet held at the Lethbridge Flying Club in May.

Once again the ladies organized the engineers' mixed bridge club, with monthly bridge parties held October to March.

London

The following meetings were held during 1956. January, annual ladies' night and dance; February, a film presentation entitled "Mining for nickel"; March, a forum type meeting: "Water resources of Western Ontario". On the panel were Dr. A. E. Berry, Mr. MacManamna, Mr. J. Vance and Mr. V. A. McKillop; April, "Oil well exploration and drilling in Canada" presented by Mr. C. Drabble; May, "The engineer's responsibility to the community", Prof. S. Lauchland; June, a dinner meeting at which Mr. V. A. McKillop was the formal after-dinner speaker.

In September, a dinner meeting at which Mr. G. E. Humphries was the informal after-dinner speaker; October, "The Provincial Parliament and its functions", E. Jackson, M.L.A.; November, "Questions on Law", C. Calder. Q.C.; December, annual feather party (turkey raffle, etc.)

There was no professional development course in London in 1956 but a short course is being prepared for early 1957.

This Branch did not carry out any counselling in schools in 1956.

Lower St. Lawrence

The branch executive held three meetings, and two other meetings were held, attended by an average of 20 engineers.

On January 23rd, 1956, a presentation of a film in full colour, which depicted the works of Leonardo de Vinci was attended by some 20 engineers and their wives. Many friends and students of the local technical school attended this showing.

On September 1st the president of the Institute and Mrs. McKillop, and the general secretary visited the members of the Institute residing in Seven-Islands. Mr. Mike Monaghan, chief engineer of the Quebec North Shore and Labrador Railway, organized the meetings and took the party in a tour of the premises, such as ore loading equipment, railway terminal, docks facilities, and so on.

Moncton

During 1956, five technical meetings of the branch were held. All of these were dinner meetings and were well attended.

Films relating to water contamination were shown on January 9th. The design and construction of the outside plant of the New Brunswick Telephone Co., was the subject of an address by Harry S. McCleave on February 27th. D. W. Blair spoke on mechanization of railway maintenance, on April 3rd. At this meeting, nominations for branch officers for 1956-57 were made. A very successful ladies' night was held on April 27th. The annual meeting of the branch was held on May 31st.

Through the courtesy of Lloyd Parsons, who loaned his motor yacht for the occasion, an afternoon cruise on Shediac Bay was enjoyed by branch members and their wives, on August 18th. On the occasion of a brief visit to Moncton, on September 20th, president and Mrs. McKillop, and general secretary, L. Austin Wright, were entertained informally by the branch executive and their wives. Experiences in Pakistan was the subject of an illustrated address by J. E. Isbester, on November 19th. The final meeting of the year, was held on December 10th, when G. L. Radcliffe spoke on the application of electronic equipment to modern accounting.

Late in the fall, an Engineers' Wives Association was formed. On November 7th, an enthusiastic organization meeting was attended by thirty-four wives of branch members. Mrs. M. F. K. Leighton was elected president, Mrs. G. A. Peck, vice-president, and Mrs. V. C. Blackett secretary-treasurer. Plans for a meeting in January, were discussed.

Moncton branch does not operate a professional development course, nor does it carry out counselling for high school boys. However, it is customary, once a year, for a member of the branch to address the students on the subject of engineering.

Montreal

The main activities of the Branch have been, as in the past, the provision of a programme of papers of wide variety and great interest. The technical sections have functioned well and we have had papers of excellent quality. Under the aegis of the technical sections, the following numbers of papers were presented: Chemical, 4 papers and 1 symposium; Transportation, 4 papers; Special, 3 papers; Management, 8 papers and 1 symposium; Civil, 11 papers and 1 symposium; Mechanical 5 papers and 1 symposium; Electrical, 8 papers and 1 symposium.

Together with these 43 papers and 5 symposiums eight plant tours were arranged.

The annual general meeting of the Institute was held in Montreal and the general chairman was Mr C. G. Kingsmill. Many of the Branch members were active in the meeting arrangements and we feel a good part of the success of the meeting was due to their efforts.

The total membership of the Branch now stand at 4,268. During the year there have been new ad missions, exclusive of students, of 79, which is a marke decrease as compared with the two previous years

There have been a number of resignations and large number of members struck off the list for non payment of fees. Whereas it is stated that this situatio exists to an equal or greater extent in other societies the Committee is, nevertheless, very disturbed by th situation. Arrangements have been made with Head quarters for the Branch to be notified of all person who are one year in arrears, and the membership com mittee will try to have some of these fees paid u and the members retained in the Institute. It is als hoped that in cases where the member has definitel decided to let his membership lapse, we will be abl to find the reasons and possibly in that way foresta such losses of membership.

The report of the reception and attendance com nittee shows that there has been, as compared with 1954, (1955 figures not being available) a very pronounced drop in average attendance at our meetings. This is no doubt the most serious problem facing the Branch, and a special committee has been set up to study the matter and make suggestions as to how the situation can be improved. One step that has already been taken has been to change the regular meeting night from Thursday to Wednesday, as it was found hat there were competing functions on Thursdays.

In the field of publicity, excellent results have been obtained by having a committee of our own members carry out this work without the help of a paid publicity man. We have not only obtained very much better press coverage during the past year than in previous years, but this has been done at practically no cost.

inancial Results

Although the financial results of the year's operation how a loss, this deficit was incurred deliberately as ve felt that we could safely use some of our reserves 1 order better to serve our members. However, this olicy would not be continued for very long, and every ffort will have to be made to balance the budget. n all fairness, it should be pointed out that this year he Branch incurred some unusually heavy expenses ue to the fact that the general meeting of the Institute was held in Montreal and such expenses will ot recur for some years.

The Branch has studied the advisability of using ome of its reserves to improve facilities in the meeting oom at Headquarters, and as a result has undertaken purchase immediately a new slide projector. This urchase will only be reflected in the accounts for ext year, as delivery and payment will only be made 1957.

The Branch contributed a sum of $150 towards the ost of the Colonal By memorial.

There has been a considerable amount of interest the Institute shown by members in the Brownsburg-achute-Hawkesbury area, and meetings have been eld with a view to organizing a branch. At present. rt of the area is attached to the Ottawa Branch, d part to the Montreal Branch, but neither branch n be of much help to members in that area. The ontreal Branch contributed $75 to this group to further their activities.

unior Section

Junior Section by-laws, which had been under discussion for a long time, were drawn up in final form d approved by the Branch executive. At the same ne, the Branch by-laws were amended to make the airman of the Junior Section an ex-officio member the Branch executive. This will result in closer ordination between the Junior and Senior Sections' tivities. Members of the Junior Section are also inted to work on Branch committees.

A special committee of the Branch has been set to study the matter of evening courses at local stitutions to enable young men who cannot go to a iversity to obtain full professional qualifications. It is lieved that if this were done quite a few young en would be attracted to the profession.

The entertainment committee, under the chairmanship of Leo Scharry, made arrangements for food and refreshments on 17 separate occasions. In co-operation with the technical sections of the programme committee, refreshments were provided after the presentation of 5 technical papers. Five buffet luncheons and 2 evening buffets were provided and refreshments were served on the occasions of 2 ladies' film nights. Some 214 attended the dinner held in conjunction with the Branch annual dinner dance at the Windsor Hotel. At the dance following, 318 additional guests attended. The entertainment committee was responsible also for the organization of the annual joint senior-junior oyster party and the special reception for the members of the many committees of the Montreal Branch.

The student guidance committee organized 3 forums during the year for graduating high school students; 166 students attended the English-speaking forum and a total of 250 students attended the two French-speaking forums.

A list of practising engineers who are willing to grant personal interviews to undergraduate students was sent to the Deans of the local universities for their attention. In addition, considerable progress has been made in the work of a sub-committee to draw up a list of the most frequent questions asked by students and suggested answers. This work is part of a long-range plan to provide a pamphlet on student guidance for use by the other Branches of The Engineering Institute of Canada.

Nipissing and Upper Ottawa

During the year 1956 the Nipissing and Upper Ottawa Branch held seven business meetings and one field trip.

In October the Branch made a field trip to Falconbridge and were entertained royally by the Falconbridge Mines. Most of the members had never visited a nickel mine and thus the trip was very instructional.

Among our business meetings two stand out very clearly. One in January was held in Sturgeon Falls. There we asked four members of the Branch to talk on subjects of their own choosing. It was amazing to find that our Branch contained so many talented speakers who could talk on subjects of interest to all. The other meeting was our student's night, with twenty-eight students in attendance. Two members of the Branch gave short talks on engineering and the E.I.C. This was followed by the film "Leonardo da Vinci", which was enthusiastically received. The students showed considerable interest in our profession.

Our membership has increased slightly and all members are taking a more active part, with the result that we have approximately fifty per cent attendance.

Due to distances involved, no professional development courses were started.

Newfoundland

The Branch has had another successful year. Membership has increased somewhat and financing has not been such a problem as in some previous years.

The Branch was active from September to May and nine meetings were held. Of these, three were business meetings and the remainder programs. The executive was very active, holding ten special meetings.

The programs covered a wide range of subjects.

Mr. J. W. Bateman, Canadian General Electric Lighting Institute, addressed the October meeting on the subject of "Developments in Light Sources". One of the most interesting meetings was an address by Mr. D. W. K. Dawe, prominent St. John's lawyer, on "Some Legal Aspects of Engineering". Mr. Dawe's address was followed by a very lively question and discussion period.

The annual Students' Night, at which three engineering students from Memorial University presented papers on the subject of their choice, was held in March. The papers were very well prepared and presented. Mr. R. Andrews was awarded the prize of fifty dollars for his paper, "Breaking the Sound Barrier".

The high-light of the year was as usual, the annual dance held at the Old Colony Club. About ninety couples attended and the evening was a tremendous success.

The Branch looks forward to even greater success during the year to come.

North Nova Scotia

Only one meeting was held last year by the North Nova Scotia Branch, at which officers were elected. The guest speaker was Mr. H. S. Haslam, who outlined the various troubles being experienced in the McGregor Mine in Stellarton which later forced the abandonment of the mine.

Northern New Brunswick

A total of seven meetings were held for the Branch in the year of 1956, four general, one annual, and two executive. The attendance at the general meetings has been about 40%, and about 90% for the annual meeting. Membership has dropped from 64 to 60 and can be attributed to several transfers from the district. Contrary to what has been stated in the past there are several engineers in all districts of this Branch who are not members of the E.I.C. We have invited several of these to our meetings and delivered pep talks in an endeavour to obtain their support by membership with the Branch. The usual answer has been "We're waiting for amalgamation of the Institute and the Association.

The first general meeting of the year was held on March 10th in Campbellton, N.B. The speaker of the evening was Mr. B. Beaton, JR.E.I.C. of the Campbellton Division of the C.N.R. Mr. Beaton spoke on "The Economic Aspects of Railway Dieselization".

The second general meeting was held in Dalhousie on April 9th. The speaker of the evening was Mr. G. B. Lawson, JR.E.I.C., steam process engineer at Restigouche Company Ltd., Atholville, and also member of the New Brunswick Bar Association. Mr. Lawson's paper was entitled "Some Aspects of the Law of Contracts".

The next gathering of the Branch members was the annual dinner meeting held at the Kent Lodge, Bathurst, N.B., on the evening of June 9th with the ladies in attendance. A brief business session was held to provide for the installation of new officers. The guest speaker was Mr. R. L. Weldon, president of the Bathurst Power & Paper Company Ltd., who had for his topic of discussion that evening "A Review of Controversial Engineering—Economic Problems Facing Canada". A dance followed the dinner meeting.

The third general meeting of the Branch for 1956 was held at the Miramichi Golf Club, Newcastle, N.B., on November 3rd. The speaker for the meeting was Mr. Reginald Tweedale, asst. chief engineer of the New Brunswick Electric Power Commission; the title of his talk was "Power for New Brunswick". He used a physical cardex-graph system of the power growth of the Province, power distribution maps and a colour film to illustrate his talk. This was an exceptionally fine presentation and deeply appreciated by the Branch members.

The fourth and concluding meeting of the year was held in Campbellton on December 8th. The speaker for that meeting was Mr. F. M. Ross, chemist for the Fraser Companies' Research Department, and supervisor of the department's pilot plant. Mr. Ross spoke on "Pilot Plant Operation" and also discussed several experiments carried out there.

In conclusion, on behalf of the Branch, I would like to say that we have been most fortunate in our acquisition of speakers who have given most interesting and informative papers. Although we of this Branch are widely scattered geographically and have considerable travelling difficulties during the winter season, we have enjoyed our meetings and hope to continue into an even better season for 1957.

Ottawa

The Branch has had another active year. The membership continues to increase; there being now over one thousand members, of which over five hundred are juniors and students. The large membership, the increase in number of student members, and the continual expansion of Ottawa, all complicate the problem of operating the Branch to the satisfaction of the greatest number.

The management committee held nine regular business meetings during the year; all were well attended.

The president of the Institute, Mr. V. A. McKillop, general manager of the Public Utilities Commission of London, Ontario and his wife together with the general secretary, Dr. L. A. Wright, visited the branch on December 8th.

Mrs. McKillop was entertained at lunch by the wives of the chairman and two Ottawa councillors and a tea for Mrs. McKillop was held by the Engineers' Wives Association of Ottawa.

A regional meeting of the Council of the Institute was held at the Chateau Laurier, Ottawa, on Saturday March 24th. It is suggested that a regional council meeting might be made an annual event with the noon luncheon open to all members of the Branch with an address by the president or one of the vice presidents.

Plans are being made by a special committee, under the chairmanship of Mr. R. F. Legget, to celebrate the 50th anniversary of the Branch in 1959. The plans include holding a regional meeting of the Institute in Ottawa, probably in October 1959.

The Branch has continued to be represented on the National Capital Regional Branch of the Communi lanning Association of Canada; the representative for 956 being Mr. W. V. Morris.

The Branch is fortunate in that the secretary W. ictor Morris has agreed to carry on for another year.

The report would not be complete without again ferring to the excellent work of the Junior Section. is hoped they will broaden their activities in 1957.

Proceedings Committee—The proceedings committe reported that there were a total of eighteen meetgs including eight luncheons, four dinners, two field ps, two dances and, of course, the president's evening ception and the Spring golf tournament. Ladies were vited to attend both field trips as well as one of e dinner meetings.

Attendance at regular meetings during 1956 ranged om about 75 to a high of approximately 130. Hower, great interest was shown in the field trips to the away; 140 to 150 persons took part on each trip.

Junior Section—In February a visit was arranged r juniors and their wives to hear the "National Capital lan" described by Mr. Allan Hay and Mr. Walter bwker of the Federal District Commission. The famous 'lan model" was on display and discussed in detail. arch event was a visit to the Gatineau Power Comny control centre at Val Tetreau, and also to the nerating station at Farmer's Rapids. In spite of a d sleet storm, approximately 30 juniors and their lies turned out. In April the Bell Telephone Comny sponsored a talk and demonstration entitled "Talki; Box to Transistor". Again the ladies were invited ad turned out in force. The spring half of the year's aivities was terminated with a visit to the E. B. Eddy Cmpany. The tour was preceded by an illustrated dscription of the process machinery to be seen later. Frty members enjoyed the details of the tour.

The fall session opened with an excellent visit to tl new plant of Computing Devices of Canada, at Bl's Corners. A very obliging staff worked overtime to show us everything in detail from a wrist radio to the intricacies of a digital computer.

At the annual luncheon meeting, chaired by the Jior section chairman, Herb Gladish, the guest speaker was Mr. MacCallum of Racey-MacCallum and Assciates.

The annual Papers Night meeting was held March 1. Senior members kindly acting as judges were Brigier Carriere, Mr. R. E. Hayes, and Capt. H. Chaput. Wrthwhile papers were presented by student and scior members. The year's activities were concluded wh an engineering forum meeting. The panel consied of Col. W. A. Capelle, Mr. R. E. Hayes, Mr. Mrris Price, and Mr. Stewart Frost. Chairman Herb Gdish very aptly conducted the discussion along such tcical subjects as "Confederation, Why a Junior Secti", "Engineer or Technician", and "Salaries Don't Mke Sense".

Pterborough

Dring 1956 the Peterborough Branch held six reasonab well attended technical meetings. These covered a ariety of interesting subjects and we were fortunate in btaining excellent speakers.

The social highlight of the season was the annual meting and visit by the presidential party. This event, which honoured the ladies of the Branch, took the form of a dinner dance.

The annual picnic was held in June and the members enjoyed a guided tour of the Faraday Uranium Mines at Bancroft. The afternoon also included a variety of sports activities and the members tried their hand at horse shoes, and so on.

Merit awards in the form of a cash prize were extended to students in each of the three city collegiates.

Port Hope

The Branch held three regular meetings, two field trips and two executive meetings during the year.

The February meeting was highlighted by a very fine address from Dr. Tupper as he outlined his views on the future of the engineering profession. It was also our annual meeting for the purpose of electing our new executive.

Our April meeting was treated to a very interesting and informative paper "The History of Land Surveying around Port Hope" by Mr. Jack Sylvester, one of our own members.

In May the Canadian General Electric Plastics Plant in Cobourg conducted a most enjoyable plant visit for the members and their wives, which was followed by a film "Power and Passage".

Our second field trip consisted of an all-day bus tour to visit the St. Lawrence power and seaway development at Cornwall, in September. This outstanding tour will long be remembered by the 38 members and guests who started at 7 a.m. and finished back home at 4.15 a.m. the next morning.

In November we held the second executive meeting at which we decided to offer a semi-professional development course to our members during the coming winter.

Mr. Parsons, of Burns Bros. & Co., gave us an outstanding lecture on present day investment problems, as the first in our professional development series. He explained the background for our gradual creeping inflationary spiral and suggested ways to keep our investment dollars abreast of the diminishing purchasing power of our dollar.

Prince Edward Island

Eight regular meetings were held during the year 1956, of which six were dinner meetings. Attendance at all meetings was fair to good; two meetings were held at Summerside, five at Charlottetown, and one near Cavendish on the north shore.

During the year much more preliminary work was done toward the formation of the Association of Professional Engineers of the Province of Prince Edward Island, and the last several meetings of the year were held as joint meetings. The following results of our annual election were announced at the regular meeting held on September 19th at Charlottetown: N. F. Stewart, chairman; Clive W. Currie, vice-chairman; L. A. Coles, John D. M. MacDonald, R. D. Donnelly, G. H. Milligan, committee; and W. S. Veale, councillor. C. F. Buckingham was appointed secretary-treasurer. An interesting point that might be mentioned is that the above members were elected and appointed to similar positions in the newly-formed Professional Association at a joint meeting held on October 25th at Charlottetown.

The annual picnic was held August 4th, in the National Park area on the north shore near Cavendish and was enjoyed as usual by both children and adults.

The occasion of the annual visit to this Branch of the presidential party was again the highlight of our year. We were greatly honored by the visit of the president of the Institute, Mr. V. A. McKillop, Mrs. McKillop, and Dr. L. Austin Wright, general secretary on September 19th. A very enjoyable dinner meeting was held at the Charlottetown Hotel, on which occasion we were favoured with a very interesting talk by President McKillop. The meeting was very well attended by members and their ladies.

At our meeting on October 25th we were given a very interesting talk by two representatives of the Plywood Manufacturers' Association of British Columbia and this was much enjoyed by all. At another fall meeting, held at Summerside on November 19th, we were shown a very interesting film.

Québec

Le Comité exécutif a tenu cinq séances au cours de l'année avec une assistance moyenne de huit pour disposer des affaires régulières de la section et étudier les questions d'interêt local ou national pour l'Institut.

Le Comité exécutif a continué l'organisation d'un bal annuel et celui-ci a eu lieu le 20 janvier 1956, au Château Frontenac. L'assistance dépassait légèrement deux cents. Ce bal est très apprécié de tous ceux qui y participent et votre comité éspère que celui de 1957 remportera un grand succès.

En janvier, le comité exécutif a reçu officiellement les délégués de la Fondation Athlone d'Angleterre venus au Canada pour présider au choix des boursiers Athlone à Laval.

Il fait plaisir au comité exécutif de souligner particulièrement que la Convention de l'Institut pour 1958 se tiendra à Québec, les 21, 22, et 23 mai. La ville de Québec s'est méritée une réputation enviable sur la tenue des conventions de l'Institut ici et le comité exécutif espère de tour coeur que la section de Québec saura maintenir sa renommée sur ce point.

Le comité exécutif se plaît à signaler que, grâce aux efforts de plusieurs de ses membres, un camp du "Ritual for the Calling of an Engineer" a été établi à Québec. Les étudiants de la Faculté des Sciences ont grandement apprécié cette initiative.

De nouveau, cette année, le comité exécutif a obtenu un octroi de $1000 du ministère provincial du Bien-Etre Social et de la Jeunesse afin de permettre la poursuite des cours avancés ou de perfectionnement en structure. Le comité se doit de souligner l'empressement avec lequel le ministre, l'honorable Jean-Paul Sauvé, a accueilli notre demande.

Au cours de l'année écoulée, le Comité de Jeune Ingenieur a inauguré une série de conférences sur l'orientation professionnelle. Des ingénieurs distingués de notre section ont été invités à adresser la parole aux étudiants finissants de la Faculté des Sciences relativement aux problèmes professionnels qu'ils auront à envisager. En chaque circonstance, les étudiants recevaient des réponses adéquates aux questions qu'ils posaient au conférencier invité.

Réunions générales—Le programme des réunions générales, durant l'annee 1956, fut le suivant: janvier 20, assemblée annuelle de la section (28), bal annuel de la section (202); février 28, film "Léonard de Vinci" (175); avril 20, tournoi de curling, Architectes vs Ingénieurs (77); avril 21, cérémonie anneau de fer (115); mai 11, conférénce et démonstration sur "high fidelity" par des spécialistes de Northern Electric et RCA Victor. Sommes invités de l'Institute of Radio Engineers, section de Québec, (50); mai 16, visite industrielle à "Les Ciments du St-Laurent", Villeneuve (30); mai 17, forum et films sur l'automation, invités du Québec Power.

Juin 14, visite industrielle à l'usine Canadian General Electric, centre industriel no. 5, St. Malo (15) août 8, tournoi de golf de la construction environ (1950) septembre 17, tournois annuel de golf de la section de Québec (92); octobre 9, conférence par les spécialistes de Fiberglas Canada Ltd. (30); octobre 19 début des cours de structure à la Faculté des Sciences octobre 22, conférence, "calculateurs binaires" par un spécialiste de l'International Business Machine Co. Ltd. Les membres de la section de Québec de l'Institut of Radio Engineers sont nos invités (80); novembr 20, conférence, "calculateurs par analogie" par un spécialiste de Computing Devices of Canada. Les membre des sections de Québec de l'Institute of Radio Eng neers et de l'American Institute of Electrical Eng neers sont nos invités (75); décembre 4, soirée de film sur l'automation et la canalisation du St-Laurent (65 décembre 19, conférence et films sur "Internation Geophysical Year Program at Churchill". Invités c l'Institute of Radio Engineers, section de Québec.

Le comité exécutif déplore la perte d'un memb affilié en la personne de M. J. A. Hamel, de Siller Plusieurs de nos membres ont eu la douleur de perd leur père, leur mère ou un proche parent au cours (l'année. A ceux-la, le comité réitère ses plus sincèr condoléances.

Le comité exécutif souligne tout particulièreme des honneurs insignes décernés par l'Institut à d membres fort méritants de notre section. Dr. A. Decary: choisi membre honoraire de l'Institut. C'e le plus haut honneur auquel peut aspirer un memb de l'Institut. Dr. Adrien Pouliot: récipiendiaire de Médaille Julian C. Smith. Ces deux membres éminer ont beaucoup merité de la profession et les honne qui leur ont été conférés réjouissent profondément le confrères.

Il importe de souligner également la nomination certains de nos membres à des charges importan dans des organisations professionnelles, universitai publiques ou charitables. M. G. E. Sarault, présid général de la Campagne 1956 de la Federation Oeuvres de Québec. Cette campagne a remporté succès considérable. M. L. P. Bonneau, à qui on confié la charge de vice-doyen de la Faculté Sciences de Laval. Il s'occupera tout particulièrem de la partie Génie. M. Y. R. Tassé, nommé directe gérant du bureau métropolitain de Québec. M. Ta est toujours un membre très en vue de la Cham de Commerce de Québec et il fait partie de l'admi tration de la Chambre de Commerce du Canada.

Un nombre important de membres ont encore, cette année, apporté une contribution active dans la campagne 1956 de la Fédération des Oeuvres de Québec au niveau des paroisses. Plusieurs contribuent également à l'organisation du Carnaval d'Hiver de Québec. D'autres occupent des postes dans des organisations et clubs charitables.

A ceux des membres qui ont obtenu des promotions et assumé de nouvelles charges, nos plus sincères félicitations et voeux de succés.

Le comité exécutif doit souligner qu'il a appris avec joie l'élection de M. Leo Roy à la prèsidence de la Corporation des Ingénieurs Professionnels de Québec. M. Roy est un ancien secrétaire de la section de Québec (1945). Egalement il faut mentionner l'élection de M. E.D. Gray-Donald à la prèsidence de la section de Montréal de l'Institut pour 1956. M. Gray Donald est un ancient président de la section de Québec.

Les membres de la section de Québec doivent être chaleureusement félicités pour leurs activités professionnelles et extra-professionnelles. Une profession acquiert de la solidarité et une reputation enviable seulement si ses membres se produisent dans les différentes sphères de l'activité humaine.

Saguenay

Once again the Saguenay Branch and the Saguenay Chapter of the Corporation of Professional Engineers of Quebec continued close co-operative activities under an elected joint executive.

Eight executive meetings were held during the year as well as the annual meeting, a presidential visit, three technical meetings, two field trips, and two dances. These were well attended.

One film night was held at which the "Leonardo da Vinci" film was shown to an overflowing audience. This film was also shown to some of the students in high schools locally to increase their interest in engineering and science.

1956 has been one of the most active years the Branch has enjoyed. Interest is very high.

Saint John

A total of six dinner meetings, three professional development meetings, and one plant visit were held during the year.

The joint dinner with the Association of Professional Engineers of the Province of New Brunswick was held on January 26th, at which time the Hon. Edgar Fournier, chairman of the New Brunswick Electric Power Commission spoke on "The History of the N.B.E.P.C."

Three of the dinner meetings were "ladies' nights" and these proved to be most popular. The first was held on April 12th and featured an interesting demonstration of miniature towers actually transmitting on microwave frequencies. The accompanying talk, entitled "The Microwave Story" was given by H. N. D., of the N.B. Telephone Co. The second was held on May 31st when C. Gordon Clark of the Atlantic Sugar Refineries Ltd. presented a showing of slides in connection with his recent trip to England. The third ladies' night was held October 11th, at which time Mr. H. Watson Jamer, past-president of the Maritime Provinces Board of Trade, spoke on the work being done by the Atlantic Provinces Economic Council to improve economic conditions in the area.

At a dinner meeting held on November 8th, Mr. Bob DeGrace, of the Canadian Institute of Timber Construction, spoke on the use of timber in construction and methods of treatment for its preservation. A film entitled "Wood at Work" was shown at this meeting. The annual meeting and election of officers took place December 11th and at the close of the meeting two films on wiring were shown.

Professional development meetings were held March 15th, October 25th, and November 22nd, the subject being "Leonardo the Inventor", "Saint John—Its Traffic Problem", and "Civil Defence". There was no definite enrollment for the P.D. Course but the average attendance was 24.

An interesting visit to the Saint John dry dock was made on May 3rd.

Five executive meetings with an average attendance of seven members were held during the year.

Arrangements for the biennial meeting held in St. Andrews in September were under the general chairmanship of J. J. Donahue, vice-chairman of the Branch, and several other members of the Saint John Branch served on various committees in connection with this most successful meeting.

St. Maurice Valley

Again during 1956, the various committees of the St. Maurice Valley Branch have made a considerable effort to provide an active year of operation and promote the good name of the Institute in the region.

The response of the membership on all activities was most comforting; the interest was high and attendance good throughout the year. With a membership concentrated in two different centres many miles apart and meetings alternating from one to the other it becomes a tricky problem in organizing activities that will be successfully attended by both groups. It was gratifying to note that meetings in Shawinigan were well attended by people from Trois-Rivières and vice versa. A number of distinguished local and outside speakers delivered talks on technical subjects of actuality and engineering achievement which were appreciated by engineers from all spheres of endeavour.

There were, altogether, 10 executive meetings and eight general meetings in 1956. Ladies attended on three occasions, which were: Showing of the "Leonardo Da Vinci" film; a talk and demonstration of a new musical instrument; and a plant tour of the Wabasso Cotton Mill in Trois-Rivières. The other general meetings were featured by the following talks: "Automation, Machines and Men" by Dr. J. J. Brown, "Automation in the Industry" by E. R. Lehmans, "Hunting and Ammunition" by Jacques Faille, of the C.I.L., and the "Beaumont Project" by John R. Ross, resident engineer, Shawinigan Engineering Company.

The highlight events of the year were the annual dinner and dance held at the Cascade Inn, Shawinigan Falls, and the golf tournament which took place at the Ki-8-Eb Golf Club near Trois-Rivières. Both events, sponsored jointly by the St. Maurice Valley Engineering Societies joint committee comprising E.I.C., E.P.E.Q., and A.I.E.E., were a huge success. Congratulations are extended to the officers of the sister societies who largely contributed to organize these functions.

On March 1st, 1956, it was a great honour for the Branch to welcome Dr. R. E. Heartz on his presidential tour. The occasion was a double pleasure for the Branch since Dr. Heartz is also an ex-resident of Shawinigan Falls, having spent some 15 years here with the Shawinigan Engineering Company. The president was accompanied by his wife, Dr. and Mrs. Tait, and Mr. Dunsmore, vice-president. They had lunch with Messrs. Edgeworth, Copping, Buchanan, and their wives. Later in the afternoon the president and his colleagues had a meeting with the Branch executive and in the evening a dinner meeting was held at which the president addressed the membership. He was greeted by over 100 members who attended the meeting. Mrs. Heartz was entertained in the afternoon at tea by Mrs. McMullen, and in the evening at The Cascade Inn by the wives of members of the executive.

The annual dinner was held on April 27, 1956, at Hotel Chateau de Blois, Trois-Rivières. Our guest speaker was Leon Balcer, M.P., who spoke on "Parliament at Work". The meeting was well attended and the subject found most interesting by all.

A course will be started in February 1957 under the professional development scheme. The chairman is now making final arrangements with the Investment Dealers' Association, in Montreal, who will be giving five lectures of two hours each on the subject of investment and stock market. This decision was reached following an opinion survey which indicated interest in many subjects but a marked preference for investment and stock market.

Branch membership is now 232 with a peak of 238 registered during the summer.

Saskatchewan

Eight executive meetings and the annual meeting were held during the year for the transaction of Branch business.

Mr. Allan Tubby, M.E.I.C., of Saskatoon, was appointed to the nominating committee of the Institute for 1956.

The Branch distributed about 130 copies of Wickenden's "A Professional Guide for Junior Engineers" to the 1956 graduating class in engineering at the University of Saskatchewan. It was accompanied by a letter from the Branch chairman, Mr. E. J. Durnin, M.E.I.C.

A donation was made towards the erection of a memorial to Col. John By, an engineer and founder of the City of Ottawa. Complete details of this undertaking may be found in various issues of *The Engineering Journal.*

The 1956 Annual Student's Conference was held in Montreal on May 22nd. Mr. Lee G. Morrison, S.E.I.C., represented the University of Saskatchewan.

Prof. J. B. Mantle, M.E.I.C., attended the 1956 annual meeting of the Institute held in Montreal, in May, as representative of the Saskatchewan Branch.

Mr. W. L. Sharpe, M.E.I.C., city engineer of Weyburn, and a past member of the executive was proposed as candidate for the office of Saskatchewan councillor.

President V. A. McKillop visited the Saskatchewan Branch at Saskatoon on November 6th. He addressed the engineering students at the University in the morning, met with the executive in the afternoon, and attended a general meeting in the evening. This was a very successful meeting, and the Saskatoon Section are to be congratulated on a fine effort.

Another item of interest to Saskatchewan members is the appointment of a former branch member, Mr. H. P. Gatin, M.E.I.C., to the office of assistant general secretary at headquarters in Montreal.

A regional meeting of Council was held in Victoria, B.C. on November 10th, and Prof. J. B. Mantle, M.E.I.C., Saskatchewan councillor, and Mr. K. C. Graham, M.E.I.C., councillor representing the Association of Professional Engineers of Saskatchewan, were in attendance.

Sault Ste. Marie

The Sault Ste. Marie Branch of the E.I.C. had a fairly active season, holding eight general attendance meetings and three executive meetings.

The first general meeting was held on January 13th, 1956, and after a short business meeting, the speaker of the evening, Mr. D. J. Rudack, was introduced. Mr. Rudack gave a very interesting talk on his experiences in the Arctic while working on radar station installation.

Dr. R. E. Heartz, president, visited the Sault Ste. Marie Branch on February 8th, and held a luncheon meeting with the local executive. A dinner meeting was held at the Sault Ste. Marie Golf Club that evening, attended by the president's party, the local members and their ladies.

The speaker for the dinner meeting of April 20th was Mr. K. H. Snell, who gave a talk on "Industria Lubrication". Mr. Snell is the senior mechanical enginee for Algoma Steel and his speech was especially interest ing to all the local members.

A social evening was held on May 25th, and thi meeting was a great disappointment to all of the execu tive. It was very poorly attended but the couples wh did put in an appearance had a lot of fun with "round robin-bridge", and so on.

The Branch Executive held a meeting on Augus 27th. This meeting was held primarily to submit a lis of names to headquarters of heads of local industry who might be sent invitations to attend an educatio conference to be held in London, Ontario.

The next general meeting of the Branch was hel on September 21st. The nominating committee for th 1957 slate of officers was appointed. A short busine meeting followed, after which three movies were show which were of general interest.

The October meeting of the Branch was held the 9th of the month. The nominating committee ga the results of its selection. Further nominations we called from the floor and, as no more were forthcomin the slate was accepted as presented by the nominati committee. Following the business meeting, Dr. M. Yan, project supervisor of the Central Research a Development Division of the Abitibi Power & Pap Company, gave an excellent paper on the developme of platewood.

The November general meeting, held Novemb

5th, was quite well attended. A short business meeting [w]as held. Afterwards, Mr. J. W. Kinney, resident en[gi]neer for the Mackinac Bridge Authority, assisted by [M]r. W. Bell, gave a speech on the progress of the [M]ackinac Straits bridge to date. The talk was well [ill]ustrated by slides.

The annual meeting of the Sault Ste. Marie Branch [w]as held on December 12th. The business meeting [w]as held to appoint auditors and make a final resume [of] the 1956 business affairs. The chairman for the 1956 [te]rm turned the chair over to the incoming chairman, [M]r. K. H. Snell, who gave a brief rundown of the [pr]oposed activities for 1957.

[S]udbury

[Br]anch activities during 1956 were as follows: January [1]2. Mr. Donald Black, of the public relations dept. of [th]e Bell Telephone Company spoke on "Your Tele[ph]one Company and Television". March 8. Mr. J. E. [M]atthew, of the nuclear energy division of the Cana[di]an General Electric Co., spoke on "The Application [of] Nuclear Energy", and Mr. J. Monaghan of the [Al]uminum Company of Canada showed a film entitled "[T]he Kitimat Story". April 5 (member's night). Mr. [M]elvin Sproule, of the research department of the [In]ternational Nickel Company, spoke on "Atomic Energy [A]BC", and Mr. G. Charlap, of the Falconbridge [Ni]ckel Company, spoke on "Some Problems Encountered i[n] Starting a New Mine". May 3. Annual meeting [an]d ladies' night. Included were reports by the com[m]ittee chairman, election of officers for 1956-57, and a [ve]ry successful dance for the remainder of the eve[ni]ng. October 13. "A tour of the RCAF (Radar) station a[t] Falconbridge." November 15. Mr. Donald Hamilton, [ma]nager of Electrical and Silastic Sales for the Dow-C[o]rning Co., spoke on "What is a Silicone", and also s[ho]wed a film on the silicone products. December 6. [Mr]. R. W. Bowcott, local equipment engineer of the [we]stern area for the Bell Telephone Company, spoke o[n] "What is Coming in Dialing".

Seven executive meetings were held during 1956. T[h]e average attendance for the seven regular meetings [wa]s approximately 40 per cent of the branch mem[be]rship.

The average attendance for the three education [me]etings (P.D.) was approximately 42 per cent of the r[es]ident membership. It was estimated that approxi[ma]tely 2700 students, and nearly 800 adults saw the fi[lm] on "The Life of Leonardo Da Vinci".

T[o]ronto

T[he] past year has been a very satisfying one for the T[or]onto Branch. All meetings were well attended. C[re]dit for this must go to each of those who made it t[he]ir responsibility to see that each meeting was "[pi]cked up".

The field trips arranged by the junior activities co[m]mittee were well done and very successful. There w[as] excellent hospitality shown by both Ontario Hydro w[he]n the branch visited the R. L. Hearn steam gen[er]ating station in Toronto in April, and by the S.K.F. C[o]mpany during the visit to their plant in September.

The general meetings were varied from a "History of Engineering in Canada", an address given by Dr. C. R. Young at the annual meeting of the branch in January 1956, to "Seaway Progress" by Mr. D. M. Ripley, JR.E.I.C. The "quiz program" was used again for the annual Students' night in February. Mr. John G. Hall, M.E.I.C., of Combustion Engineering Corp. Ltd., acted as quiz master.

The president of the Institute visited the branch on February 16th, spoke to the students at the university, met the Branch executive later and provided an occasion for members and their wives to meet Dr. and Mrs. Heartz at a social evening in Hart House.

A joint meeting with the A.I.E.E., Toronto Section, was held on March 1st, and took the form of a panel discussion on power and energy resources. Dr. Otto Holden, M.E.I.C., chief engineer, H.E.P.C. was chairman of the panel. Panel Members were Dr. W. P. Dobson, M.E.I.C., retired chief of research H.E.P.C.; Mr. George D. Floyd, M.E.I.C., assistant general manager of engineering, H.E.P.C.; Professor A. E. Allcutt, M.E.I.C., retired head of department of mechanical engineering, University of Toronto; and Mr. W. L. Thompson, M.E.I.C., district manager, Bailey Meter Company Ltd., Toronto.

Also in March, Mr. George Cowper, of Atomic Energy of Canada Limited, Chalk River, spoke to the branch on "The Detection of Nuclear Radiation".

In April, Dr. G. Ross Lord, M.E.I.C., spoke to the branch on "Humber Valley Flood Control". The attendance and questions were an excellent indication of the interest in this subject in the Toronto area. Perhaps the branch should thank hurricane Hazel for stirring up such interest.

In October Professor H. L. Macklin spoke to the branch on modern mapping methods. This was followed at the end of October by a panel discussion on "The Engineering Manpower Shortage" with Dr. R. R. McLaughlin, Dean of Engineering, U. of T., as the chairman. The panelists were Mr. D. R. Abbey, M.E.I.C., standards engineer, Underwriters' Laboratories of Canada; Colonel J. K. Bradford, O.B.E., director of university placement, U. of T.; Mr. W. F. McMullen, manager of technical personnel, Canadian General Electric Company, Peterborough; Mr. Ira J. Needles, president, B. F. Goodrich Canada Limited, Kitchener and Mr. S. H. Deekes, special assistant, A. V. Roe Canada Limited.

Ladies' night was a great success. The branch lost less money this year on this function than it had for some years. The membership is to be congratulated for turning out so well and giving this function their best support by their presence.

On the 13th of November, Dr. Richard L. Hearn, immediate past chairman of the Hydro-Electric Power Commission of Ontario, presented a paper on "The Sir Adam Beck Generating Station No. 2". This was the paper Dr. Hearn had delivered to the Institution of Electrical Engineers, in London, England, just previously, and was very well received.

Mr. D. M. Ripley's paper on "Seaway Progress", with many fine coloured slides, was an excellent presentation and served admirably to cap off the year.

It is recognized that such a program could not have been carried off without the excellent cooperation of all members of the branch executive and the generous assistance of the membership at large. The support and assistance of the membership is reflected too in the good financial standing of the branch, which showed a surplus for the first time in some years.

The branch is pleased to note that the professional development program carried on in two groups. Group I carried out the usual general series of subjects to help the members fill in their background of general knowledge, while Group II carried on a more concentrated study of six main topics with emphasis on human relations and business problems. The branch takes this opportunity to thank the officers and members of the professional development program for their excellent handling of this activity. Some who have taken the course have chosen to join the branch executive and these have made a valuable contribution to the branch activities with their experience and enthusiasm.

Vancouver

During the past year there were ten meetings of the executive and seven Branch meetings. The spring meetings were held jointly with the Association of Professional Engineers but this practice was discontinued in the fall.

Unfortunately the president was unable to meet the Branch but Dr. Wright addressed the scheduled meeting.

In May, members of the Branch and their wives journeyed to Seattle and were entertained by the Seattle Branch of the A.S.C.E. A bascule bridge was inspected and a discussion on the Boeing wind tunnel was held, followed by a social evening.

A very successful part of the program was supplied by field trips to the Crown Zellerbach paper converting plant, Boyles Bros. Drilling Co., British Ropes factory, and the Capilano Brewing Co.

A well-attended ladies' night was featured by dancing and bingo.

The Student's night dinner was held very successfully, with three students presenting papers which were judged and for which prizes were awarded.

A structural section of the Branch was formed during the summer. Four dinner meetings were held in the fall at which local members presented papers on structural topics. Dr. R. F. Hooley was elected chairman of this section.

The Vancouver Branch ended the year with a schedule of regularly held Branch meetings and a policy of holding as many field trips as possible, and looks forward to an even more active year in 1957.

Professional Development Course. The Vancouver Branch operated a professional development course in 1955-56, and is now organizing one for this season. Last year the average attendance was 34 and 12 meetings were held. Total enrolment was 38, which indicated an attendance percentage of 90 per cent. When organizing this course, the main recommendation was that the course begin towards the end of January and end in April. The Vancouver Branch has found this period to be the best time for maximum attendance.

Counselling in Schools. The Association of Professional Engineers does some counselling here, but the Engineering Institute has not considered this step to date.

Engineers' Wives' Association. An Engineers' Wives' Association is organized in Vancouver, but not necessarily in connection with the Vancouver Branch.

Vancouver Island

During 1956, the Vancouver Island Branch held, conjointly with the Victoria Branch of the Association of Professional Engineers of B.C., seven technical meetings on the subjects: earth slides, mineral resources, bridge design, ship design, astronomy, and highway design.

Since the annual meeting for 1955 was held in January, 1956, the branch held two annual meetings in 1956; the first in the form of a dinner meeting with the ladies, followed by a showing of the film "Leonardo da Vinci", and the second in the form of a smoker.

One of the most successful meetings was arranged as a dinner and dance in the Oak Bay Golf Clubhouse on November 10. Unfortunately president and Mrs. McKillop were unable to visit Victoria this year because of the sudden death of Mr. McKillop's assistant. However the meeting was attended by the general secretary, Dr. L. Austin Wright, vice-president Hardy, and several councillors of the western region who had earlier on the same date attended the Council meeting of the western region in Victoria.

Seven branch executive meetings were held during the year.

The Vancouver Island Branch scholarship of $100 was presented to Gary J. Whitten. Mr. Whitten expressed his gratitude in the form of an excellent letter as well as personally at the October 19th joint meeting.

Winnipeg

The Winnipeg Branch enjoyed a most successful yea[r] of operation in 1956. It had the privilege of welcomin[g] and entertaining Dr. McKillop, the E.I.C. president and Dr. Austin Wright, the general secretary.

The Branch extended an invitation to headquarte[rs] to hold the annual general meeting of the Institut[e] in Winnipeg in 1960. Headquarters accepted and ar[r]angements have been made for space required and [a] committee has been set up to study arrangement[s] which will have to be made.

There were five meetings held, at which papers o[f] general application and of timely interest were give[n] and some very fine films were shown. The averag[e] attendance was 73.

Civil Section. Six meetings were held and one pla[nt] visit and the average attendance was 40. The tot[al] membership of the Section is 224 and among this num[-]ber is listed members, juniors, students and branc[h] affiliates.

Electrical Section. This Section has an enrollme[nt] of 191, which is an increase of 10 over that of th[e] year 1955. At present the membership is made up [of] the E.I.C. grades as follows: Members 120; Junio[rs] 44; Students 10; Branch affiliates 17. The section hel[d] the following listed meetings. Six Section meetings wi[th] an average attendance of 38; one joint meeting wi[th] the A.I.E.E., attendance 65; and one plant visit, atten[d]ance 60.

In addition to these the Section sponsored two soci[al] functions: a Spring wind-up at the conclusion of th[e] winter sessions and the annual dinner-dance. Both of these were well attended, there being 88 persons in attendance at the wind-up and 215 at the dinner-dance.

Brandon Section. This Section has a membership of 40 and its members display considerable initiative both in the matter of Section management and in the securing of speakers and interesting films for the regular meetings.

Seven regular meetings, which are always preceded by a dinner gathering, were conducted by the Section executive during the year, with an average attendance of 19 present. A family picnic was arranged to take the place of the June meeting. This was held at the International Peace Garden, south of Boissevain, Manitoba; 35 members and their families attended.

The Section had a guest speaker at each of its meetings and in addition special films on forestry and mining were shown.

Student Section. This Section had a most successful year and increased its membership from 172 in 1955 to 215 in 1956. The membership drive got under way early in October and prospective members were each presented with an application form, together with S.E.I.C. brochures and copies of an address given by Dr. Sidney Smith, president of the University of Toronto.

The Section held six regular meetings, at each of which a guest speaker discussed some branch of engineering, and an appropriate film was shown.

On November 5th, the Section was honoured by a visit from Dr. McKillop, the president of the E.I.C., who was accompanied by Dr. L. Austin Wright, the general secretary, and several members of the Winnipeg Branch.

This meeting was the best attended of the year and 250 undergraduates were on hand. The general attendance of all of the meetings was exceptionally good, as an average of at least 50 per cent of the total membership was registered.

Yukon

The final step in the creation of the Association of Professional Engineers of the Yukon Territory was taken when many members of the Yukon Branch E.I.C. were gazetted in January 1956 as P. Eng. in the Association of Professional Engineers of the Yukon Territory. This is the culmination of an idea that was sponsored by the Yukon Branch E.I.C.

Another major step in the solidifying of the Yukon Branch was the drawing up of a set of Branch by-laws. These were submitted and approved by E.I.C. Headquarters in December 1956. They will be presented to the members of the Yukon Branch early in 1957. During the year, five dinner meetings were held and two field trips were organized. The members, Branch affiliates and wives attended a dinner meeting after which they saw the film on the life of Leonardo Da Vinci. At the meeting in May, a paper was presented entitled "The Mechanics of Frost Action". At the October meeting, several films of engineering interest were shown. In early December, the assistant resident engineer of the project spoke on the "Whitehorse Rapids Power Development". This speech was of great interest due to its very local nature. Also in early December, a special meeting was held t
Professor Blench, of the Univ
"Control of Rivers and Strea

In July, the past chairma
Lt. Col. M. C. Sutherland-Br
sults of the meeting of the I
fessional Engineers which wa
June 2nd. In general, the imp
tion would be considerably
in the Provinces. The recent fo
of Professional Engineers of
comparatively small number
in the Yukon, and the close
Branch and the Association,
for the formation of a single
the functions of the Institute
Branch, therefore, is in favo
and would receive favourabl
the Provinces, while itself ur
gree of integration than that

The two field trips were
well as very successful. The
conjunction with the annual
sisted of an inspection of the
Hydro-Electric Company. Th
four-day journey to Dawson
their wives had a chance to
of the Klondike Gold Rush c
wives were shown over, in s
in operation. The local hist
Service's cabin and "Louseto
detail. Many conversations w
old-timers and sourdoughs.
light of the trip was the sew
was installed very early in
where permafrost exists at
That this system still functio
example to engineering achi

The Branch lost a few me
ment to other parts of the
have been more than replac
to members, and by other
E.I.C.

It is felt, generally, that t
a successful year and looks f
one in 1957.

Corner Brook

The year 1956 has not been
Corner Brook Branch. Only c
that was not too well attend

On September 13 we wer
the president, Mr. V. A. McKi
by his wife and by the genera
bers, their wives, and guests
After cocktails and dinner, M
meeting, followed by Dr. Wri
members and guests danced
visit was thoroughly enjoyed

Membership a
statements are

Membership and Financial Statements

BRANCHES	Amherst	Belleville	Border Cities	Brockville	Calgary	Cape Breton	Central British Columbia	Corner Brook	Cornwall	Eastern Townships	Edmonton	Fredericton	Halifax	Hamilton
MEMBERSHIP														
Resident							*							
Hon. Members	1	2	..	..	..	..	..	..	..	..	..	..	2	3
Members	24	36	62	28	295	46	..	18	33	29	297	76	290	180
Juniors	6	29	87	18	166	12	..	9	28	36	301	38	64	244
Students	8	7	4	7	30	5	..	1	10	45	60	79	91	62
Affiliates	..	2	.	..	1	1	..	..	..	..	2	..	1	1
Total	39	76	153	53	492	64	..	28	71	110	660	193	448	490
Non-resident														
Hon. Members	..	1	..	..	..	1	..	..	..	..	..	..	..	..
Members	..	4	20	6	16	3	..	3	2	27	20	21	48	1
Juniors	..	5	12	1	24	5	..	7	3	29	34	15	22	1
Students	..	5	6	2	10	..	..	2	2	26	11	5	10	3
Affiliates	..	..	..	..	..	..	..	..	..	..	..	..	..	.
Total	..	15	38	9	50	9	.	12	7	82	65	41	80	5
Grand Total Dec. 31st, 1956	39	91	191	62	542	73	..	40	78	192	725	234	528	495
Grand Total Dec. 31st, 1955	35	87	201	51	526	73	.	39	67	141	708	202	519	465
Branch Affiliates, Dec. 31st, 1956	..	3	2	7	44	33	.	.	4	22	7	..	..	12
FINANCIAL STATEMENT								*						
Balance as of Dec. 31st, 1955	117.24	301.22	628.15	173.92	1,409.15	324.06	..	.	275.14	419.06	1,529.43	414.48	1,044.49	404.6
Income														
Rebates from E.I.C. Hq.	61.80	274.80	547.20	174.90	211.63	40.00		.	276.30	467.40	299.00	305.72	233.48	1,016.2
Payments by Prof. Assns.	85.35	..	..	..	1,165.58	219.30	.	..	..	..	1,348.88	128.00	928.20	..
Branch Affiliates Dues	..	..	..	104.00	420.00	250.00		..	16.00	265.70	126.00	..	..	83.5
Interest	..	..	13.18	..	33.00	..		..	..	4.52	36.79	..	3.00	65.6
Miscellaneous	..	44.53	397.00	221.52	58.54	998.00		..	..	823.39	..	672.60	788.7	21.0
Total Income	147.15	319.33	957.38	500.42	1,888.75	1,507.30	..	..	292.30	1,561.01	1,810.67	1,106.32	1,953.47	1,186.4
Disbursements														
Printing, Notices, Postage [1]	7.87	34.12	167.05	30.74	839.32	37.89	..	..	31.60	156.43	736.91	73.01	481.54	425.1
General Meeting Expense [2]	..	121.82	172.15	..	319.21	..	..	..	..	..	167.81	..	437.50	148.9
Special Meeting Expense [3]	117.80	17.55	232.05	397.02	184.11	1,124.75	..	..	282.82	1,354.10	750.02	580.55	526.55	179.2
Honorarium for Secretary	..	..	..	..	.	.	..	..	..	..	100.00	50.00	150.00	25.0
Stenographic Services	7.00	..	8.00	..	..	..	..	..	..	..	10.00	..	67.50	25.0
Travelling Expenses [4]	..	..	..	..	..	..	..	..	..	..	140.05	..	..	..
Subs. to other organizations	..	..	..	..	..	..	..	..	..	24.25	..	..	..	..
Subs. to *The Journal*	..	..	..	20.15	..	100.00	..	..	..	59.50	8.00	..	..	16.0
Special Expenses	15.00	..	143.74	.66	78.72	..	..	..	..	25.00	130.47	..	†379.41	110.0
Miscellaneous	..	45.96	1.00	2.13	78.17	15.40	..	..	1.25	9.55	8.00	32.48	37.40	21.
Total Disbursements	147.67	219.45	723.99	450.70	1,499.53	1,278.04	..	..	318.67	1,628.83	2,051.26	736.04	2,079.90	950.
Surplus or *Deficit*	*.52*	99.88	233.39	49.72	389.22	229.26	..	..	*26.37*	*67.82*	*240.59*	370.28	*126.43*	235.
Balance as at Dec. 31st, 1956	116.72	401.10	861.54	223.64	1,798.37	553.32	..	..	248.77	351.24	1,288.84	784.76	918.06	640.

[1] Includes general printing, meeting notices, postage, telegraph, telephone and stationery.
[2] Includes rental of rooms, lanterns, operators, slides and other expenses.
[3] Includes dinners, entertainments, social functions, and so on.
[4] Includes speakers, councillors or branch officers.
*Statement not received.
†Includes $325.10, Professional Development Committee.

he Branches as at December 31, 1956

Kitchener	Kootenay	Lakehead	Lethbridge	London	Lower St. Lawrence	Moncton	Montreal	Newfoundland	Niagara Peninsula	Nipissing and Upper Ottawa	Northern Nova Scotia	Northern New Brunswick	North Eastern Ontario	Ottawa	Peterborough
													*		
..	..	..	..	..	..	..	7	..	9	..	.	..	.	2	1
41	28	38	32	74	18	41	1,742	37	85	25	35	16	.	378	68
39	17	30	14	73	47	24	1,294	31	91	20	13	6		230	57
12	3	8	3	5	18	10	997	33	13	1	9	3	..	247	3
..	..	3	..	..	1	1	13	..	2	..	..	..	..	2	1
92	48	79	49	152	84	76	4,053	101	200	46	57	25	.	859	130
		..	..	..	..	..	..	..	..	..	..	..	..	..	..
4	12	18	19	18	..	..	69	7	3	3	..	9	..	42	2
.	12	24	15	21	..	..	87	23	1	9	..	19	..	85	3
	2	6	7	12	.	..	57	8	2	1	..	7	..	44	3
		..			..	..	2	..	..	.	..	..	.	..	..
4	26	48	41	51	..	..	215	38	6	13	..	35	..	171	8
96	74	127	90	203	84	76	4,268	139	206	59	57	60	..	1,030	138
85	85	136	80	203	81	74	4,265	127	249	52	59	64	..	968	141
5	17	4	5	..	1	5	4	1	2	3	..	..	..	5	1
							§								
323.06	488.53	328.83	343.94	399.95	278.67	784.36	10,242,58	58.55	1,179.43	276.67	278.47	264.20	..	370.40	422.46
335.10	260.70	366.30	64.80	646.50	156.35	187.70	8,311.45	276.30	586.75	200.40	64.20	125.70	..	1,661.00	414.60
		..	178.00	..		..	..	..	..	..	55.80	28.00	..	..	..
21.00	110.00	12.00	117.85	.	..	49.00	28.00	20.00	..	14.00	..	..	..	70.00	2.00
2.42	..	3.00	..	..	..	30.77	252.50	..	19.55	..	..	..	..	53.58	4.10
62.50	729.06	629.55	94.95	950.95		356.89	2,283.51	543.43	343.88	417.10	..	499.74	..	1,530.79	..
421.02	1,099.76	1,010.85	455.60	1,597.45	156.35	624.36	10,875.46	839.73	950.18	631.50	120.00	653.44	..	3,315.37	420.70
78.51	18.59	103.37	114.15	331.17	14.94	17.29	3,952.44	57.64	242.03	51.07	10.75	29.40	..	678.25	114.42
30.00	92.70	149.90	6.75	..	14.11	23.00	217.45	25.95	25.25	..	..	30.30	.	23.45	39.00
52.25	693.55	670.30	226.12	968.07	..	476.49	4,799.76	529.75	501.95	530.04	22.12	505.90	..	1,056.12	188.08
		11.00	35.00	..	.	50.00	900.00	..	75.00	..	..	..	..	100.00	..
	6.30	..	..	2.00	.	..	..	..	10.00	17.65	..	..	..	25.00	..
		.	..	78.40	25.00	..	..	..	2.00	..	..	..	..	..	..
		..	..	..	..	..	..	..	.	..	..	..	..	295.00	..
	32.15	12.00	..	..	..	20.15	..	..	..	4.00	..	..	..	20.00	..
21.95	75.15	35.56	..	..	‡30.00	..	594.77	86.38	100.00	6.05	..	20.15	..	583.00	30.00
80	137.36	10.50	73.49	..	.15	29.30	903.01	69.24	71.09	¶25.00	..	..	..	15.25	8.40
83.51	1,055.80	992.63	455.51	1,379.64	84.20	616.23	11,367.45	768.96	1,027.32	633.81	32.87	585.75	..	2,796.07	379.90
37.51	43.96	18.22	.09	217.81	72.15	8.13	*491.97*	70.77	*77.14*	*2.31*	87.13	67.69	..	519.30	40.80
0.57	532.49	347.05	344.03	617.76	350.82	792.49	9,750.61	129.32	1,102.29	274.36	365.60	331.89	..	889.70	463.26

ment t received.

sted t correct revision of 1955 figures.

‡Contribution to Col. By memorial fund, $30.00.

¶Contribution to Col. By memorial fund, $25.00

Branch Statements (continued) ➧

MEMBERSHIP AND FINANCIAL STATEMENTS OF THE BRANCHES
Continued

BRANCHES	Port Hope	Prince Edward Island	Quebec	Saguenay	Saint John	St. Maurice Valley	Sarnia	Saskatchewan	Sault Ste. Marie	Sudbury	Toronto	Vancouver	Vancouver Island	Winnipeg	Yukon
MEMBERSHIP															
esident															
Hon. Members	1		1		..	..		1	..	..	2	42	1	2	..
Members	15	17	131	78	65	41	76	432	21	37	1,004	288	102	276	14
Juniors	11	13	198	81	17	140	72	55	12	29	795	213	36	236	2
Students	.	2	252	32	11	32	16	105	1	10	185	152	4	161	..
Affiliates	2	1	.	1	1		2	.		..	7	1	..	3	..
Total	29	33	582	192	94	213	166	593	34	76	1,993	696	143	678	16
n-resident															
Hon. Members	..	..	.	..	..	..	..	..	..	..	..	..	..	..	..
Members	..	..	9	1	3	7	2	7	1	5	15	27	19	26	2
Juniors	..	1	19	5	3	9	2	15	10	2	23	52	17	36	..
Students		1	23	.	4	3	1	2	6	1	10	10	7	10	..
Affiliates	..	..	..	..		..	.	2	..	..	..	..	..	..	1
Total	..	2	51	6	10	19	5	26	17	8	48	89	43	72	3
Grand Total Dec. 31st, 1956	29	35	633	198	104	232	171	619	51	84	2,041	785	186	750	19
Grand Total Dec. 31st, 1955	26	34	564	155	109	232	171	639	59	87	1,791	789	163	800	26
Branch Affiliates, Dec. 31st, 1956	3	..	..	2	10	.	2	2	10	8	7	1	1	34	3
FINANCIAL STATEMENT															
Balance as of Dec. 31st, 1955	302.53	166.93	736.95	876.64	613.80	606.04	725.27	694.78	748.62	543.68	3,545.80	962.96	472.14	2,928.08	167.25
Income															
ebates from E.I.C. Hq.	112.65	105.60	797.75	545.40	213.90	646.50	658.00	137.17	145.80	259.80	3,605.56	1,438.00	401.25	564.80	100.00
ayments by Prof. Assns.	..	.	..	48.00	96.00	..		2,843.82		..	70.36	..	..	834.80	
ranch Affiliates Dues	18.00	.	.	6.00	98.00	..		.	22.00	84.00	20.00	25.00	3.00	201.50	56.00
nterest	..		.	3.46	.	7.60	1.06		..	3.58	77.05	28.41	..	36.00	..
Miscellaneous	..	25.35	87.43	1,137.75	..	366.31	911.57		332.03	529.65	1,240.40	931.46	..	99.20	331.35
Total Income	130.65	130.95	885.18	1,740.61	407.90	1,020.41	1,570.63	2,980.99	499.83	877.03	5,013.37	2,422.87	404.25	1,736.30	487.35
Disbursements															
rinting, Notices, Postage [1]	34.71	9.47	266.17	90.80	101.18	209.07	63.83	111.02	78.43	151.26	1,748.51	765.23	65.40	576.90	20.25
eneral Meeting Expense [2]			36.75	406.45	12.00	171.40	2.00	..	142.00	107.00	201.67	256.00	48.95	174.05	15.00
pecial Meeting Expense [3]	43.05	153.53	282.82	1,261.88	151.85	415.65	1,280.07	752.51	284.15	169.00	1,574.17	1,133.00	145.15	184.90	362.95
onorarium for Secretary	.		150.00	60.00		40.00		180.00	50.00	.	100.00	100.00	100.00	250.00	
enographic Services			50.00	..	35.00			50.00		.				11.00	
ravelling Expenses [4]	78.00		..			..		285.04	..	.		50.00		75.00	
ubs. to other organizations			.			.	5.00							3.15	
ubs. to *The Journal*				8.00	36.00	.				33.05		.		72.00	8.00
pecial Expenses	..		50.00		.	58.73	63.65			325.18	370.00	86.95	120.41	32.00	26.70
iscellaneous	.	.56	24.17	181.20	20.30	.	45.00	310.50	198.30	35.45	118.03	25.50		334.82	8.20
tal Disbursements	155.76	163.56	859.91	2,008.33	356.33	894.85	1,459.55	1,689.07	752.88	820.94	4,112.38	2,416.68	485.91	1,713.82	441.10
Surplus or *Deficit*	*25.11*	*32.61*	25.27	*267.72*	51.57	125.56	111.08	1,291.92	*253.05*	56.09	300.99	6.19	*81.66*	22.48	46.25
ance as at Dec. 31st, 1956	277.42	134.32	762.22	608.92	665.37	731.60	836.35	1,986.70	495.57	599.77	4,446.79	969.15	390.48	2,950.56	213.50

Includes geueral printing, meeting notices, postage, telegraph, telephone and stationery.

Includes rental of rooms, lanterns, operators, slides and other expenses.

Includes dinners, entertainments, social functions, and so on

[4] Includes speakers, councillors or br ch officers.

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Contents - May 1957

(18,600 copies of this issue printed)

The Institute as a body is not responsible either for the statements made or for the opinions expressed in this publication.

Reproduced here is a letter from the Prime Minister, the Rt. Hon. Louis St. Laurent, to mark the seventieth anniversary of The Engineering Institute of Canada.

OFFICE OF THE PRIME MINISTER · CABINET DU PREMIER MINISTRE · CANADA

This summer The Engineering Institute of Canada is marking the seventieth anniversary of its service to this country, although the fine record of contribution of our engineers extends many years further into the pages of our history.

The engineering profession is of vital importance to Canada, particularly during this period of rapid national development. Many of the projects which are being carried out at the present time constitute important stepping-stones in this development process and will be of lasting benefit to the Canadian people.

To all the members of the engineering profession in Canada I extend my warm congratulations on the seventieth anniversary of their organization and my best wishes for further notable successes in the future.

Prime Minister.

Ottawa,
1957.

This scene might seem less suited to a review of Canadian engineering and industry than to a travel prospectus. Yet this is the site of one of the country's foremost developments during 1956 — the Mystery/Moak Lake mining project. It is possible that the pulp and paper industry may also develop in this hitherto remote part of northern Manitoba. (*Photo: Manitoba Government.*)

FOREWORD

THIS ISSUE of *The Engineering Journal* is devoted to a review of Canadian industry during 1956, including all the segments of direct interest to members of the engineering profession. The reviews are mainly based on annual Bureau of Statistics reports, and on news items from trade journals and financial statements. They have been augmented by information supplied by leaders of industry. For some industries, complete DBS reports are not available beyond 1954 or 1955, but the value of factory shipments only are quoted for 1955 or 1956.

The *Journal* is grateful to many government departments at all levels, and to many firms and associations who have generously responded to requests for information and photographs. Limitation of space has made inclusion of much of this data impossible, though it has been helpful as a supplement to data provided from elsewhere.

This is a first attempt at such a review of industry which it is hoped to make an annual feature in years to come. Those to follow will be easier and, it is hoped, improved. Comments and suggestions for improvement will be helpful and are invited.

THE EDITOR

CANADA IN 1956

THE YEAR 1956, with the gross national product at $29,550 million, posted a new record for Canada in a series of record-breaking post-war years. Most to be remarked about the current boom is that it has spread to practically all economic sectors — primary, secondary, and service industries — and has been shared in varying degrees by all regions from coast to coast. Even the relatively depressed Maritime provinces have been enjoying a higher level of prosperity.

The ten per cent gain over 1955 in the gross national product may be divided roughly into a two per cent gain due to price increases and an eight per cent 'real' gain in production. The main reason for this prosperity was the high rate of gross domestic investment, which reached a total of some $7,500 million for the full year, or some 26 per cent above 1955.

When the Department of Trade and Commerce annual forecast of investment intentions was published a year ago, it was fairly evident that the ambitious plans could not be implemented without serious penalties. Shortages of manpower, materials, and plant, and the monetary limitations which developed later, caused a substantial carry-over into 1957. Nevertheless, gross domestic investments showed a gain of some 25 per cent over 1955.

Other economic indicators showed percentage increases over 1955 as follows: personal disposable income, 9%; personal expenditures, 7%; government expenditures, 7%; salaries, wages, etc., 11%; corporate profits (manufacturing), 23%; net farm income, 15%; savings, 35%; inventories (manufacturing), 8%; exports, 12%; and imports, 18%. Employment at year-end was up 6½ per cent, and unemployment down to 1.7 per cent of the labour force.

On the unfavourable side, commercial failures were up 14 per cent and both wholesale and consumer price indices up 3 per cent. Railroads had shown good gains in traffic and gross revenue but net revenue was discouraging. Urban transit services continued to show a decline in traffic, and even with rate increases barely held their own in earnings. There was a sharp drop in the number of housing starts during the fourth quarter.

Employment Covered in Review

Canada's total civilian labour force in 1956 varied from an average low of 5,642,000 in the first quarter, to 5,806,000 in the fourth quarter. Totals for non-farm labour only, varied between 4,860,000 in the first quarter and 5,036,000 in the fourth, or an average of some 4,929,000 for the year.

Employment at 1,891,000 in mining, power, petroleum, transportation, and the other heavy industries that are covered in the following review (shown in round figures for each industry in the table), thus represents the production effort of some 38 per cent of Canada's non-farm labour force. The remaining 62 per cent are employed in such industries as clothing, textiles, food, beverage, retail trade, printing and publishing, tobacco, rubber and leather footwear, and service industries.

1956 Employment in Canadian Heavy Industries (in round figures)

Construction	649,000
Mining	130,000
Power	50,000
Oil and Gas	25,000
Metal Refining	28,000
Petroleum Refining	12,000
Pulp and Paper	130,000
Lumber	57,000
Shipbuilding	14,000
Primary Steel	29,000
Foundries	14,000
Structural Steel	11,200
Sheet Metal Products	18,300
Railways	190,000
Highway Transport	63,000
Water Transport	22,000
Urban Transit	20,000
Civil Aviation	14,000
Communications	65,000
Electrical Mnf.	76,000
Chemicals	50,000
Motor Vehicles	34,000
Aircraft Mnf.	36,000
Rolling Stock	29,200
Boilers	8,100
Industrial Machinery	33,000
Hardware	13,300
Farm Implements	14,100
Aluminum Products	8,000
Brass Products	10,000
Cement and Concrete	10,300
Rubber and Products	11,600
Asbestos Products	6,700
Clay Products	6,000
Leather Belting	130
P.F.R.A.	1,050
Total	1,887,980

Outlook for 1957

Taking a look at the coming year, economists saw a more modest increase ahead in gross domestic investment for 1957 than in the year just past, with a rise of some five per cent, of which half would be a 'real' increase and half would be due to higher prices. They predicted a come-back for housing due to continuing population growth from immigration and the current high rate of natural increase. Government expenditure would be higher, except, perhaps, for defence.

Though disposable income and personal expenditures would be moderately higher than in 1956, it was anticipated that savings would again increase by 12 per cent. Imports would continue strong. Labour would still be scarce, and unemployment be maintained at less than 3 per cent of the labour force, but the gain in labour income would be less than in the previous year.

Inventories were predicted to show only a 2 per cent gain over 1956, compared with an 8 per cent gain in 1955/56. Net farm income was likely to have a modest 3 per cent gain. Price levels would be up 3 per cent at wholesale, and 2½ per cent at consumer level.

All these predictions added up to a 1957 forecast of gross national product at $32,000 million, or an increase of about 8 per cent over 1956 of which 6 per cent should represent a real increase, and 2 per cent be due to price changes.

The Canadian mining industry is continually seeking new methods to improve efficiency. Such mechanized equipment as the Joy loader, right, is now common. The scene below is a usual one when a new oil well is brought-in for the first time. *(Photos: Dominion Steel and Coal; Imperial Oil Limited.)*

MINERAL RESOURCES

METALLIC ORES

NON - METALLICS

SOLID FUELS

PETROLEUM

NATURAL GAS

CANADA'S MINERAL output has been climbing steadily since World War II and setting new records year after year. The trend continued in 1956 and no slackening is indicated in the foreseeable future. All the major minerals excepting lead and gold have shared in the advance, and are slated for further significant increases in the years ahead. Substantial gains are predicted for the coming year for copper, nickel, iron ore, uranium, zinc, asbestos and petroleum.

The overall value of Canada's mineral output for 1956 exceeded $2 billion, only six years after it reached the billion dollar mark. This compares with a value of $1.8 billion for 1955 and just under $1.5 billion in 1954. Best progress in 1956 was seen in production of copper, iron ore and uranium.

Copper, Uranium, Iron Ore the Leaders

Apart from production of petroleum, valued at $402 million (dealt with in another section), copper led all Canadian minerals in production value with 1956 output estimated at $291 million. Nickel ranks second with production worth $223 million. Part of the gain in copper has been due to the sharply higher prices for the metal, and part to increased tonnage. Sharpest gainers have been Opemiska, Gaspé copper and the nickel-copper companies. Promising newcomers include coming producers in the Chibougamau, Sudbury and Manitouwadge areas and in Newfoundland, which will swell the total in the years immediately ahead.

Uranium increased its production in 1956 to an estimated value of $40 million, 50% above that of the previous year. The many new mines soon to come into production will give Canada a place among the world's top uranium producing nations. Within the next few years output of Canadian uranium may well increase five or six-fold.

Iron ore ranks high among the star performers of the mining industry. Canadian mines produced some 23 million long tons of ore worth $156 million, half as much again as was produced in 1955, and more than triple the amount produced in 1954. Within another half decade the total will be seen moving up to around 50 million tons.

Three Exceptions

Coal, with its outlook clouded by the competition from the oil and gas which are rapidly replacing it as energy sources, barely maintained its upward output trend, with production at $95 million, and with little hope for any improvement in view. Though the program of mechanization in the Maritime mines has been accelerated, the slight increase in domestic output for 1956 was not sufficient to meet growing Canadian demand due to the upsurge in business activity, and imports of coal for the year were sharply higher.

Gold, one of the two minerals failing to establish new gains, in spite of cost-aid just about held its own in the struggle against rising costs, with production worth $151 million. The upsurge in copper mining activity brought about an increase in gold production from base metal operations in 1956. This, however, was more than offset by a decrease in output from lode gold mines, resulting in an overall decline in output from the previous year. Lead output also continued to decline, with production down 8% from 1955.

Every mining province received its share of the mining industry's spectacular growth. Many new mines were brought into production and many more are in prospect across the length of the nation from the International Boundary to the Arctic. Within a few years the record production of 1956 promises to be far outdistanced.

Manpower Shortages a Threat

Continuing expansion depends on many factors, of which three are of major importance: money, markets and manpower. Under the tight money market policy now in force, investment capital was more difficult to come by than in previous years. Though no real difficulties were encountered in 1956 in selling our exportable surplus of mineral products, non-dollar countries are still unable to purchase in the volume they require, while threats of increased tariff duties in the United States, though presently dormant, are still much alive below the surface.

A more immediate threat to progress is lack of sufficient manpower. A shortage of underground labor is shaping up similar to the one experienced during the late 'forties'. A survey a year ago disclosed an impending shortage of some 800 men. Actually the industry could have easily absorbed a further 1000 trained miners in 1956. To meet this situation the Canadian Metal Mining Association has a mission working overseas. Britain, Ireland and Italy offer the most promising sources for further supplies of underground labour.

Of equal importance is maintenance of a supply of trained mechanics and technicians of all kinds. In this respect Britain is an obvious recruiting ground. The shortage of engineers, geologists and metallurgists continues to be serious. A great strain will be imposed on our universities in providing adequate facilities in staff and equipment to train the

Table I. 1956 Value of Mineral Production by Provinces ($ millions)

Category	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T. Yukon
Metals	79.85	1.0	8.00	236.21	512.36	39.21	70.10	0.01	157.70	37.17
Non-Metallic	4.01	11.4	0.16	116.77	19.7	1.11	3.92	0.85	12.64	....
Fuels	.....	51.02	0.60	.....	7.14	13.65	40.92	388.30	8.89	1.46
Structural Materials	3.96	3.2	9.31	73.62	101.71	12.74	3.52	19.70	20.07	.....
Total	87.75	66.62	18.17	426.61	640.91	66.71	118.46	408.86	199.30	38.63
Principal production in order of importance	Zinc Iron ore Lead Gold Fluorspar	Coal Copper Lead Gypsum Salt	Coal Lead Zinc Gypsum	Copper Asbestos Iron ore Gold Titanium Lithia	Nickel Copper Gold Iron ore Salt Asbestos Neph. Syen.	Copper Nickel Petroleum Zinc Gold Salt	Petroleum Copper Uranium Gold Sod. Sulph.	Petroleum Coal Gas	Lead Zinc Copper Silver Asbestos Peat Sulphur Coal	Gold Uranium Zinc Petroleum Silver

flood of undergraduates enrolling during the next few years.

There is the keenest competition for youthful talent, whether mechanical, professional or administrative. Only by well conceived and well executed plans will the mining industry succeed in getting its fair share, so it may maintain the momentum of its remarkable current growth.

More Domestic Consumption Means More Processing

Much of Canada's mineral production is exported as ores or concentrates, or in primary metallic forms. As we become more and more industrialized, however, more of the basic raw materials from mines and mills are being processed and consumed at home. Twenty years ago, total, value of Canada's manufactures was some $3.3 billion. In 1956 the value had risen to nearly $20 billion.

This expansion has increased consumption of primary metals and minerals. The great expansion in construction volume over the same period, amounting to almost an eightfold gain, has created a demand for large quantities of basic raw materials in the form of building products.

Canadian dependence on the United States and Western Europe for mill products and fully finished articles has been decreasing yearly, particularly in the past 11 years. This was due to greater per capita fabrication in Canada of the major ferrous and non-ferrous metals, with the resulting decreased importation of completely fabricated materials.

METALLICS

Iron Ore

Twenty-two and a half million long tons of iron ore were shipped during 1956 from Canada's iron mines a 40% increase over the 16¼ million tons shipped in 1955. This puts Canada in 7th place among the world's producers, with an output amounting to some 4½% of global output.

Though the United States is spending vast sums on research work to upgrade or beneficiate low grade deposits, the percentage of iron ore it will have to import in years ahead should climb, and much of it will come from Canada. There is, however, a pronounced trend to beneficiated or 'tailored' ores. Steel makers find a furnace charged with 'pellets' saves as much as 25% of heating time. Thus low grade iron deposits are much in demand today.

There is no real iron ore shortage. Temporary ore surpluses may appear. But despite the growing ore output the price trend still points upward. Quotations for 1957 are almost certain to be raised in view of the round of wage increases last summer. Steel has already been marked up.

1956 production was divided approximately as follows among the principal producers, in millions of long tons: Iron Ore Co. of Canada, 12; Steep Rock, 3¼; Dominion Wa-

General view of the Steep Rock Iron Mines development. In the foreground is the Errington underground plant and loading terminal on the C.N.R. spur line. Centre: the "G" ore body, showing electric dredges removing silt overburden. Background: the Hogarth open pit and Hogarth shaft, under construction. ***(Photo: Photographic Survey Corporation.)***

bana, 2½; Algoma, 1½; Bethlehem (Marmora), 0.5; Argonaut, 0.35; Texada, 0.35; Inco, 0.33; Quebec Iron and Titanium, 0.15 and Noranda, 0.07.

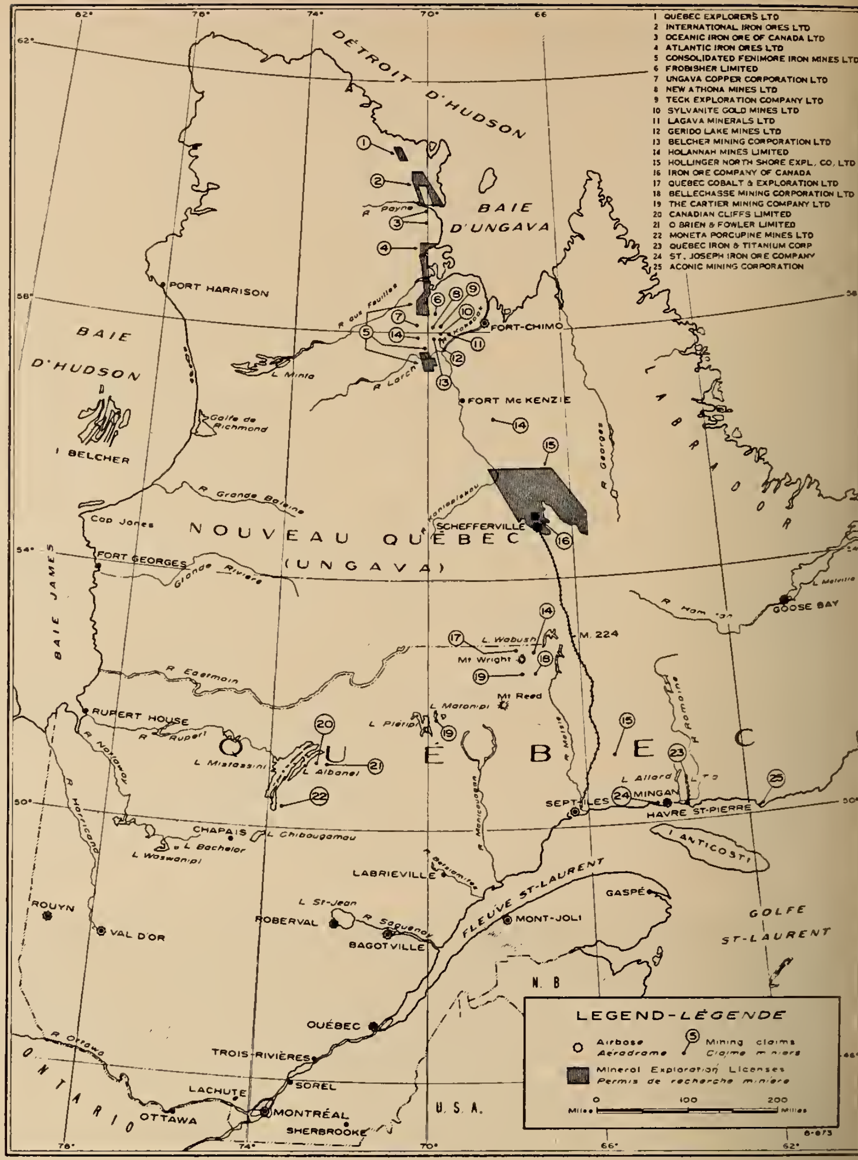
New producers soon to swell the Canadian output include Caland Ore Co. near Steeprock, with 1 million tons of reserves in 1959; Hilton Mines and Bristol-Quebec Mining Co. in Quebec with 600,000 tons of low grade ore; International Iron Ore Co. and Atlantic Iron Ores in the Ungava area, controlled by Cyrus Eaton interests; Oceanic Iron Ore of Canada and Consolidated Fenimore Iron Mines further south in the same area; and Canadian Javelin Co. in the Wabush Lake area of Northern Quebec. Other companies still in the exploration stage include Quebec Cobalt and Exploration Co., Cartier Mining Co., Mattagami Mining Co.

Copper

Canadian mines produced copper during 1956 at near record levels, only exceeded in 1940. They could have sold more if they could have produced it. 1956 production at over 353,000 tons, worth $291 million, smashed the prewar record of 327,800 tons, and compared with the 326,000 tons produced in 1955. Canada ranks fourth among free world copper-producing nations after United States (841,071 tons in 1954), Rhodesia (438,711 tons), and Chile (400,857 tons).

Refined copper output in Canada for 1956 will probably approach 275,000 tons, compared with 252,643 tons in 1954. Canadian consumption of refined copper in 1954 amounted to 102,536 tons in 1954 and exports of primary copper the same year to 47,411 tons and of refined copper 156,130 tons. For 1956 all of these totals are likely to show increases of some 8 or 9 per cent when final reports are compiled. Copper price stood at 36.62 cents per pound in January, peaked at 49.125 cents in late August, and dropped again to 36 cents at the end of 1956.

Two new copper mines were brought into production during the year, Gaspé Copper Mines and



Mining properties in the Ungava (New Quebec) region. *(Quebec, Dept. of Mines.)*

One of the new copper mines that came into production during 1956 was the Campbell Chibougamau Mines development, in the Chibougamau region of Quebec, of which the site is shown here.

Campbell Chibougamau Mines, both of them in Quebec. The former was running at half its 6,500-ton capacity at year-end, awaiting more power; the latter was producing at a rate of 1,500 tons per month.

Nickel Production

With 1956 production of nickel at 356 million lb., up some 1% from the previous year, the search for new supplies is accelerating. Several companies are now beyond the prospect stage and are planning for production over the next two years. North Rankin Inlet west of Hudson's Bay plan a 250-ton concentrator and will produce after 1958; Arcadia Nickel in the Sudbury district contemplate a 1,000-ton mill.

Consolidated Regcourt in Quebec is planning a 2,000-ton mill; Norpax Oil and Mines' shaft is down 350 feet; Eastern Mining and Smelting in the Werner Lake district have their shaft down 1,000 feet; Eastern Metals Corp. in Quebec plan a 500-ton mill for 1958; New Manitou Gold Mines plan a 1,000-ton concentrator and Temagami Mining Co. plan a 2,000-ton mill. Several more companies have blocked out substantial reserves.

Outstanding event for 1956 was International Nickel's decision, announced late in 1956, to proceed with development of the company's Mystery-Moak Lake property in Northern Manitoba.

The framework of the Geco Mine mill buildings, at Manitouwadge, Ontario, where large copper and zinc deposits have been discovered and are now being developed, thus opening up another new area. ***(Photo: Ontario Department of Mines.)***

Lead

Canadian lead production for 1956 at 186,675 tons was lower than for 1955, when output totalled 202,763 tons. Refined lead output was also lower than in 1955. Exports for the first nine months were below the same period of 1955. Canada ranks as the fourth largest lead producer. Principal source continued to be Consolidated Mining and Smelting Company's Sullivan Mine at Kimberley, B.C.

Secondary lead production accounts for about a third of the total. Demand has been steady. The current U.S. stockpiling program, which has been draining off surplus supplies, is nearing completion with no announcement of extension, though U.S. Department of Agriculture barter deals will partly replace it.

Zinc

Canada's production of zinc in 1956 at 847.2 million lb. was 2½% lower than in 1955. The value of 1956 production at $125½ million was 6% higher than in 1955.

Though zinc exports decreased over the first nine months, Canada ranks third among world producers,

Exploration shaft at International Nickel's Moak Lake development, which will be used as the main entrance to the nickel mine when operations begin. ***(Photo: Manitoba, Dept. of Industry and Commerce.)***

after the United States and Europe, with some 16½% of total production.

Consolidated Smelters' Sullivan Mine in B.C. is the largest producer. From this mine and from other B.C. zinc properties about half of the Canadian production of refined zinc is produced. Another 30% is refined by the Hudson's Bay Mining and Smelting Co. at Flin Flon, Manitoba. Quebec produces most of the remaining 25%. Smaller quantities are also produced in Newfoundland and the Yukon. Several promising potential producers are developing in Ontario, New Brunswick, Nova Scotia and the N.W.T.

Cobalt

1956 was a year of consolidation for the cobalt industry. Free world production was substantially the same as for 1955. The five-year upward trend was halted in 1955 when some 14,000 short tons was produced. Civilian consumption has been held back by the U.S. stockpiling program.

Canada will rank as second or third largest producer in 1956.

Canadian 1956 production as represented by shipments of metal, oxides and matte derived from ores of Canadian origin increased to 3.68 million lb. from 3.3 million lb. in 1954. Value increased in 1956 by 9% to an all-time high of $9,372,760.

International Nickel Co. of Canada is by far the largest Canadian producer, followed by Falconbridge Nickel Mines. Newest source of the metal is Sherritt Gordon Mines in Manitoba. Eastern Mining and Smelting Co. is carrying out pilot-plant work for a new nickel copper smelter at Chicoutimi, Quebec, which will also produce cobalt. Canada's only producers of cobalt ores are in Northern Ontario.

Platinum

Canada led the world in production of platinum metals in 1955, producing some 381,600 ounces valued at $22½ million, but may have yielded its place to South Africa in 1956 when Canadian production was 311,600 oz. Total world output of the platinoid metals amounts to only 28 tons yearly. Some 60 per cent of this is platinum, 40 per cent is palladium with the other four metals, iridium, osmium, rhodium, and ruthenium making up the balance.

Most of Canada's output comes from nickel copper ores of the Sudbury area. Increased demand for both these major metals indicates platinum production in 1956 may have surpassed all records. Outlook for 1957 is for a slight increase in world output.

Gold

Gold mining experienced a difficult year in 1956. After South Africa, Canada ranked second in 1955 Free World gold production at $U.S. 159 million. For 1956 the free world total will be up, thanks to South Africa. U.S. and Canadian production will be somewhat lower than for 1955, with Canada producing a value of $150.8 million.

For 1957 no factors can be foreseen to change the existing trend, though South Africa's increase will not be so marked. No new fields of major importance have been reported anywhere in recent years. One Canadian producer, a copper-gold mine, has been added, but four longtime producers closed down.

Cost-aid was extended last year for another two-year period, or to the end of 1958. The free market for gold bars, however, has induced some gold mines to give up cost-aid. Only three new properties are under development. No new gold mills are being constructed and very little prospecting is being done for gold. The bringing into production of several new gold-copper properties, however, has increased gold production from base metal operations.

Uranium

Canada has a uranium productior potential equivalent to at least hall of the anticipated Free World output of 30,000 tons. The country's three principal uranium producing areas are Beaverlodge in the northwest corner of Saskatchewan, Blinc River in Ontario near the north shore of Lake Huron and Bancroft abou 150 miles east of Toronto. Total refinery production for 1956 was valuec at $39,577,000.

At Beaverlodge, Eldorado Mining and Refining has expanded its mil to 2,000-ton daily capacity and wil be ready to operate this Spring. Gunnar Mines produced ore in 195 valued at $13½ to $14 million an the Beaverlodge Camp had a $24. million production. Present mill capacity is being increased from 1,30 to 1,750 tons daily. Lorado's 500-to custom mill will produce this sprin with custom ore from half a doze nearby mines.

Blind River is the world's larges uranium camp. Mines there hold con tracts totalling more than $1.1 billio and its eleven mills can handl 35,000 tons of ore daily. Pronto afte a full year's operation has overcom its difficulties and is expanding ca pacity to 1,500 tons daily. Algom Quirke Lake property started pro ducing last October and the Nordi was ready for a start at year enc Eight more mills are under construc tion.

In the Bancroft area Bicroft com menced production early in Decem ber with its 1,000-ton mill, whil

In contrast to the South African gold fields is this view of the Preston East Dome Mines Limited property at South Porcupine, Ont.

Due to go into production early in 1957 was Heath Steele's 1500-ton mill at the lead-zinc-copper operation at Little River, near Newcastle, N.B. *(Photo: New Brunswick, Dept. of Lands and Mines.)*

Faraday will follow it this spring with a 750-ton unit. The area's third mill has been started by Dyno Mines which is presently trying to complete its financing. Elsewhere, Eldorado's original mine at Great Bear Lake continued operations.

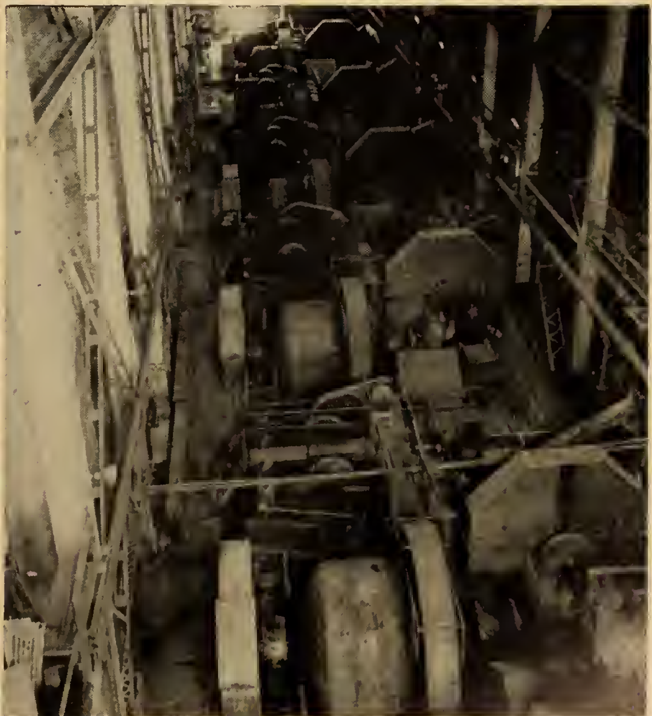
Eldorado, the government's procurement agency, has contracted for the purchase of all presently known uranium production up to 1962/63. These contracts were negotiated under arrangement with the U.S. Atomic Energy Commission except for Canadian requirements. The post 1962/63 market is still obscure, but some production may be diverted to Britain.

A total of 18 Canadian companies have received contracts or letters of intent from Eldorado covering the purchase of $1½ billion worth of uranium. Within two years production should reach $300 million value yearly or more. 1957 output should reach a value of between $50 and $60 million.

Titanium

Canada is the world's largest producer of titanium slag (72% TiO_2 plus desulphurized iron), all of which comes from Quebec Iron and Titanium Corporations' smelter at Sorel, Quebec. 1955 production was 162,784 tons, containing about 117,000

The Flin Flon mine, in Manitoba, is the second largest Canadian producer of zinc. The general view of the crushing plant (left) shows the main belt conveyors; ball mills and classifiers for secondary grinding are seen (right) in the concentrator plant. *(Photo: Hudson Bay Mining and Smelting Co. Ltd.)*



tons of titanium dioxide. Ilmenite shipments from the Allard Lake deposits totalled 444,235 tons in 1955. Titanic Iron Co. also shipped 1,400 tons of Ilmenite from the St. Urbain area of Quebec. Canada's 1956 production totalled 4,443 tons of ore valued at $37,100.

Canadian metal production is limited to pilot plant operations at Shawinigan Water and Power Co.'s Shawinigan Falls plant, and at the Dominion Magnesium plant at Haley, Ont. The Mines Branch in Ottawa is continuing research work on all phases from ore to metal.

Lithium

Lithium is a relative newcomer to Canadian mining. So far there is only one producer, Quebec Lithium. This company and several others have discovered the largest and richest lithium deposits in the world. In anticipation of increased demand, this company is expected to increase capacity from 1,000 tons to 1,500 tons daily by mid 1957. It has a 5-year contract with Lithium Corp. of America to supply 165 tons of concentrates daily, while deliveries are being stepped up beyond the minimum called for in the contract. Reserves exceed 15 million tons of 1.2% lithium oxide, 9 million tons of which are above the 400-ft. horizon. All 1956 production, at 2,400 tons valued at $4.8 million, came from Quebec.

Other companies in various stages of development include Canadian Scotia, Montgary Explorations, Lithia Mines and Chemicals in Manitoba, Nama Creek Mines in the Beardmore area of N.W. Ontario, Aumacho River Mines and Geolex Development and Exploration Co., in the North West Territories.

Manganese

Canada imports all its requirements of manganese ore. Consumption in 1956 surpassed the 113,000 tons used in 1955. Canada has developed rapidly in the production of ferro-manganese ore, and in 1955 exported 29,400 tons valued at $5.2 million. Producers of manganese alloys include Union Carbide at Welland, Ont., Chromium Mining and Smelting Corp. at Sault St. Marie, and Canada Furnace Co. at Port Colborne. Recently additional sources of low grade manganese ore have been found in New Brunswick. Other potential sources of manganese are the huge reserves of manganiferous ores in the Labrador and New Quebec districts and in the iron ranges west of Port Arthur near Steep Rock.

Magnesium

Canada, which until last year held second spot as a magnesium producer after the United States, is now being challenged by Norway, which is reported to be already producing 9,000 tons yearly and planning an increase to 12,000 tons. Germany and Japan with plans for 5,000/6,000 tons yearly each, are runners up.

In Canada, magnesium is produced by two companies, Dominion Magnesium Ltd., and Magnesium Co. of Canada, Ltd., a subsidiary of Aluminum Co. of Canada. Their combined production including calcium was valued at $5,617,826 in 1956, and would have been higher but for the power shortage in the Saguenay district. Canadian exports account for 80% of the sales, with Britain, France, and Japan the best customers. The Canadian price was increased in March 1956 to 31½ cents per pound of pure metal.

An aerial view of the Eldorado uranium mine, in the Beaverlodge area of northern Saskatchewan; where mill capacity has been increased. ***(Photo: Sask. Govt.)***

Molybdenum

Canadian production of molybdenite comes only from Molybdenite Corp. of Canada, operating some 25 miles northwest of Val d'Or, Quebec. Shipments of 90% molybdenite concentrates and crude bismuth metal in 1955 were valued at $1,068,673 and totalled 689 tons and were shipped to Europe. 1956 shipments went to Western Europe and Japan, and were slightly higher than 1955 at 756 tons valued at $967,461.

There are no facilities for treatment of concentrates in Canada but from December 1956 the company will begin production of molybdic oxide and various molybdates. Mill capacity was increased last year from 400 to 540 tons daily. At a new property in which an interest was acquired last year 25 miles away, a 1,000-ton mill will be erected. Owner is Prissac Molybdenite Mines. Quebec Metallurgical Industries also has a property 9 miles north of Shawville, Quebec, where an adit has been opened.

Other Production

1956 production value for other "metallics" includes: silver, $25.8 million; selenium, $6.86 million; tungsten, $6.06 million; and cadmium $3.8 million; all higher than in 1955.

1956 production value for nonmetallics, fuels, and structural materials includes: peat moss, $3.7 million; sodium sulphate, $2.85 million; quartz, $2.78 million; nepheline syenite, $2.5 million; dolomite, $2.4 million; and stone, $43.3 million.

NON-METALLICS

Coal

In spite of increasing competition from oil and gas developments, Canadian coal production for 1956 showed a modest gain at some 14,915,000 tons compared with 14,819,000 the previous year. Employmen

This large electrically-powered shovel is used in the coal fields of Estevan, Sask. The size may be judged by comparison with the tractor in the foreground. *(Photo: Saskatchewan Government.)*

in the industry remained stable, indicating progress toward the goal of increased productivity, so important to the future soundness of the industry. The extensive mechanization program in the Maritime coal mines was continued at an accelerated rate. Domestic output has not kept pace with the rise in consumption due to the upsurge in business activity and imports were sharply higher. On a longer term basis there is still the implied threat of increasing competition as the dieselization program continues, and the only answers are improved productivity and reduction in mining costs. Nova Scotia, Alberta, and Saskatchewan, in that order are the major producers with 5.8, 4.4, and 2.3 million tons, respectively. New Brunswick, British Columbia, and the Yukon are also producers.

Fluorspar

Canadian production of fluorspar in 1956 broke all records. Despite a

Completed during 1956 was the Algom Quirke mine of Algom Uranium Mines Limited, in Algoma, northern Ontario. A similar development was also completed at the Algom Nordic site. The projects were financed to a large extent by the Rio Tinto Group.

shipping strike, total production at 151,738 tons valued at $3.83 million was well ahead of the record 128,114 tons shipped in 1955. Two-thirds of Canada's output is consumed at home with the rest going to United States, which took 58,390 tons in 1955 and probably imported about 65,000 tons for 1956. Largest Canadian consumer is the aluminum industry, while the second is the steel trade.

Practically all of Canada's fluorspar comes from Newfoundland with a small quantity from Ontario. St. Lawrence Corp. of Newfoundland, Ltd., and Newfoundland Fluorspar, Ltd., are known to have ore reserves adequate for many years' production.

Asbestos

Canada accounts for about two-thirds of world production of asbestos. 1956 production was slightly less than in 1955, when it topped the one million ton mark for the first time at 1,063,802 tons worth $96.2 million. Due to a rise in prices the 1956 value of production exceeded the 1955 value by 14%, at just below $110 million.

The main source of Canadian asbestos is in the Eastern Townships district of Quebec, where eleven producing mines are operated by seven companies. Canadian Johns-Manville Co. at Asbestos, Quebec, is by far the largest producer, accounting for 60% of Canada's output. The Asbestos Corporation is largest producer in the Thetford Mines area, followed by Johnson's Co. and Bell Asbestos Mines. The Johnson Co. located at Black Lake is also the oldest producer. Lake Asbestos Co. of Quebec has just completed its first full year of production in the Thetford Mines area. Two potential producers are developing in Newfoundland and the Yukon.

Barite

Canada is an important producer of barite, and easily takes third place after the 1,000,000-ton output of United States, and the 400,000-ton output of Germany in 1954. Production has risen more than four-fold since 1949, and will probably increase in 1957, as consumption has been rising steadily over the past decade. 1955 production reached an all-time high of 307,808 tonr valued at $2,509,200.

Magnet Cove Barium Corp. at Walton, N.S. accounts for more than 90% of Canadian output. Reserves were last estimated at over 2.7 million long tons, one of the largest high grade barite ore bodies in the world. Most of the production has been from open pits. A new shaft is now being sunk to 1,000-ft. depth, and some production is expected from underground late in 1957 or 1958.

Other deposits occur in Ontario, Nova Scotia, British Columbia, Quebec and Manitoba, none of which are yet under development.

Canadian consumption is small, with some 75% of production used as a weighting agent in oilwell drilling muds. The mineral is also used as a filler and pigment in paints, rubber, linoleum and papers, in making barium chemicals, glass batches, as a concrete additive and where shielding is required against radiation in atomic energy plants.

Largest output of asbestos in Canada is from the Canadian Johns-Manville mine and mill at Asbestos, Que., seen here. ***(Photo: Photographic Surveys (Quebec Limited).)***

Gypsum

The gypsum industry experienced another record-breaking year in 1956, with 5,193,000 tons produced, valued at $8.3 million, or 11% more than in 1955. National Gypsum Ltd.'s new quarry at Millford, N.S. reached full production and for a time attained a daily rate of 8,000 tons on single shift, though this was reduced to 5,000 tons daily following the steel strike. The Millford deposit is one of the world's largest.

Three quarries at Windsor, N.S. operated by Canadian Gypsum Co. will have a combined capacity of 11,000 tons daily on single shift in 1956. Gypsum Lime and Alabastine Ltd. have purchased the Windsor Plaster Co., and are spending $100,-000 in modernizing the gypsum mill. Bestwell Gypsum Co. is developing two large properties in Hants County and on Cape Breton Island.

Cement

Canadian cement production has reached a new high in 1956 of close to 30 million barrels, valued at $77.9 million, compared with 25,168,000 barrels in 1955. By the end of the year 1956, productive capacity stood at some 37 million barrels, which, it is hoped, will do away with the need for imports. By early 1958 capacity of the industry will have risen by another 5 million barrels to some 42 million barrels yearly, which on a per capita basis probably exceed that of any country.

Salt

Production of rock salt increased greatly in 1956 with the coming into full production of Canadian Rock Salt Co. mine at Ojibway, Ont., in August, 1956. The mine's capacity is designed for production of 500 tons per hour. This makes possible large exports to the United States, valued at nearly $1 million in 1955. Canada's 1956 production was 1.6 million tons valued at $13.9 million. Only other producer, Malagash Salt Co. in Nova Scotia will bring a high grade rock salt mine near Pugwash, N.S. this year with capacity of 1,000 tons per shift. Sifto Salt and Midrim Mining Co. have new properties in Ontario which are due for development soon.

These developments mean a majo

·hange in the character of the salt ndustry. Instead of most salt being ıbtained by pumping brine and ·vaporating it, with the increase in ıroduction of much cheaper rock salt Canada will be supplied with this nportant raw material at considerbly lower cost.

ulphur

Canadian sulphur production from ll sources, 1956, was some 763,736 ons valued at $7.44 million; up from record 628,443 tons in 1955. Production by 1960 may well reach a otal of over 1,200,000 tons. Imports nd exports are gaining. 1955 imports otalled 373,373 tons. Exports the ame year were valued at just over 2 million and for 1956 will likely ıow a value of some $2.3 million. his means that Canada is still a et importer.

Main producers of pyrite include oranda, Waite Amulet, Quemont, 'est McDonald, East Sullivan, Noretal and Weldon in Quebec, and ritannia Mine in B.C. Geco Mines Ontario and Brunswick Mining and nelting in N.B. produce in 1957.

Sulphur also is produced from ock gases by International Nickel Copper Cliff, Ont. and by Conlidated Mining and Smelting Co. Trail and Kimberley, B.C. This is rgely used by the fertilizer indus- and by pulp and paper mills. atural gas production accounts for rapidly growing service. A sharp crease will be effected when Westast Transmission's Taylor Flats reuction plant in Northern B.C. and A. Oil's recycling plant at Pincher eek commence extraction of sulur from the gas.

l ne

Lime production in 1956 (1,304,-0 tons; $72.6 million) was slightly ls than in 1955. Most came from ntario and Quebec, with small antities from New Brunswick, anitoba, Alberta, and B.C.

G vel and Sand

The demand for building aggreges has been tremendous in recent nths. Canadian production of sand al gravel in 1956 rose to an all-time hh of close to 129 million tons, shtly above the previous year.

C Products (Brick, Tile, etc.)

Total 1956 production was valued a some $38 million, 8% higher than in 1955. Half the production comes from Ontario, a quarter from Quebec, with Alberta, B.C., Nova Scotia, Manitoba, and New Brunswick following, in that order.

Potash

Saskatchewan is the source of all current development for potash in Canada. Potash Co. of America is sinking a shaft at Patience Lake 15 miles east of Saskatoon. International Minerals and Chemicals Corp. (Canada) Ltd. is planning a shaft on its property on the east side of the province. Continental Potash Corp. has sunk a shaft to some 1,200 ft. depth near Unity, Sask. A Canadian company has applied to the Manitoba government for rights to prospect for potash in that province close to the Saskatchewan boundary.

Typifying the development of the petroleum refining industry is this second vacuum flasher installed at the Montreal East refinery of the Shell Oil Company of Canada, Limited.

Petroleum and Natural Gas

Canadian Oil posted another record in 1956, when production at 170.6 million barrels racked up a 32 per cent gain over 1955, a similar growth to that shown in 1955 over 1954. Domestic demand for oil rose 12 per cent and crude oil exports recorded a threefold increase. Measured against a favourable 10 per cent increase in the value of the gross national product these indicators emphasized the importance of the oil industry to the Canadian economy.

Alberta supplied 85 per cent of the total, while Saskatchewan and Manitoba furnished 11 and 3 per cent respectively. Last year British Columbia also became a commercial oil producer. Saskatchewan's percentage gain in production over 1955 was 66 per cent, while Manitoba's gain was 37 per cent, compared with a percentage gain in Alberta production over the previous year of only 26 per cent. This shows the extent to which these two eastern prairie provinces are catching up on Alberta.

Crude petroleum, with production value estimated at $400 million, has thus ranked as Canada's leading mineral for the fourth year in succession. Production reached a monthly high of 520,000 barrels daily compared with the best monthly average of 411,000 barrels daily in 1955. At year's end maximum potential production, at almost double the actual oilfield output, meant that Canada would be fully self-sufficient in oil if adequate transportation facilities were available to reach all economic market areas.

Capital expenditures on some 17 refinery projects added some 112,-000 barrels capacity daily, bringing total refinery capacity at year end to 708,000 barrels per day, 15 per cent higher than the 618,450 barrel capacity at the end of 1955, and triple what it was 10 years ago.

Some $200 million was spent during 1956 for the industry's plant and equipment. Large as it was, this expansion was overshadowed by the amounts spent for the acquisition of mineral leases and in the search for and development of oil and gas fields, which aggregated more than $500 million.

Drilling continued active at about 10 per cent above the footage rate for the previous year, with close to

3,300 wells completed. On the average some 250 rigs were at work throughout the year, with 276 active at year's end. Alberta led with 162 rigs at year's end, half of them on exploration. The Pembina field, one of the largest pools on the continent, now has 1,600 completed wells, double the number a year ago.

Most of the drilling in Saskatchewan which took second place, was in the southeast part of the province, with 72 rigs active in December. 21 of the total were on exploration drilling in the central west areas. Development drilling accounted for about two thirds of the total. The discovery rate on wildcat drilling was exceptionally high.

British Columbia ranked third in drilling progress for the year, finishing with 27 rigs operating in December, 18 of them on exploration in the northeast corner of the province. This is where Pacific Petroleums and other companies were hard at work developing gas fields in preparation for the opening of the Westcoast gas pipeline next September. Several promising oil discoveries in the northern part of the province during the year made B.C. a potential producer of oil in commercial quantities.

Drilling in Manitoba stepped up its drilling activity following a less active year in 1955. Wildcat drilling accounted for about a third of the drilling last year. While there was no wildcat drilling last year in the Northwest Territories, possibilities are not being overlooked.

These drilling programs have now brought proven reserves in all four western provinces to well over 3 billion barrels, compared with 2.4 billion barrels a year ago. Total number of producing wells now stands at over 10,000.

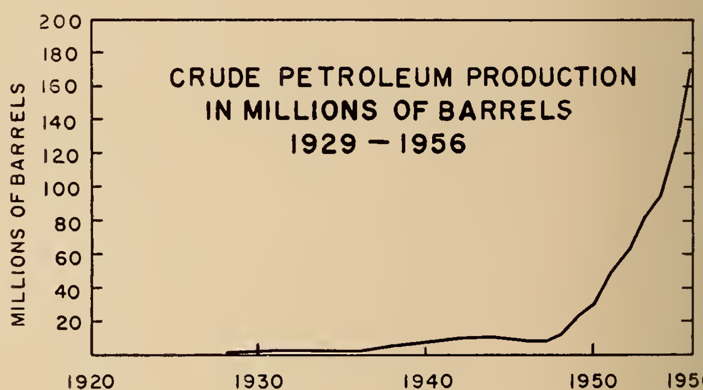
Big Year for Pipelaying

1956 was also a big year in oil and gas pipeline construction, with some 740 miles of main completed, and a total of 3,100 miles including gathering and distribution lines. This included Westspur's 109 mile line linking southeastern Saskatchewan oilfields with the Interprovincial Pipeline at Cromer, which was the year's major addition to oil pipeline facilities. Completed last summer, it was carrying 30,000 barrels daily at year-end, and capacity will be doubled in 1957. Completion of Cremona Pipeline Ltd.'s 60 mile line to Calgary and of the Peace River Oil Pipeline Co.'s system to transport oil from Peace River fields were other leading developments. Additional looping was also carried out on the Interprovincial pipeline.

For the future, Interprovincial Pipeline Co. has announced its 1,770 mile pipe between Edmonton and Sarnia will be extended to Toronto in 1957. Transmountain Pipeline Co. has announced it will boost capacity sharply from December's 184,000 b/d capacity to a possible peak of 300,000 b/d in 1958, and is considering an ultimate capacity of half a million barrels daily.

Grains From Suez

Closure of the Suez Canal last November, with the resulting shortage of a million barrels daily for Western Europe, brought new prospects for Canadian oil. A good deal more of it will likely go to the big California market, releasing extra tanker space and extra Venezuelan oil for Europe.



The pickup started last December with requests for a 36,000 barrel per day delivery.

Pressure has also increased, mainly from a group of independent western oil producers, for an early start on extension of the Interprovincial pipeline to Montreal with its huge 225,000 barrel per day refinery market, presently served entirely with imported crude.

Unfortunately, entry of Western Canadian oil into the Montreal market would put it immediately into direct competition with imported oil, which would mean an overall wellhead price cut in the west. Moreover, Montreal refiners are hardly ready yet to negotiate the guaranteed oil throughputs necessary to finance the 350 mile extension beyond Toronto. Permanent disruption of Middle East oil or a major world hoist in crude prices could, of course, change the outlook. But many oil men believe it is wishful thinking to expect much permanent gain out of the present emergency. The Middle East is still the logical supply for Western Europe, and Western Europe is the best market for its oil.

Exports now a Third of Total Demand

The solid foundation for Western Canada's rapid growth in oil production over the past decade has been the steadily expanding market outlets provided by the record pace of Canada's industrial expansion and the sharply rising trend in the standard of living. Nevertheless the volume of exports has been mounting substantially over the past year. Transmountain pipeline started the year with a throughput of 100,000 barrels daily. By October throughput had gradually risen to 158,000 barrels a day. Plans were hastily made to install two new pumping stations. Either by adding further pumping stations or by looping, capacity will be raised t around 300,000 by the end of 1957

Exports of Canadian oil at the en of the year had reached to abou the 44 million barrel per year level The remarkable gain over the 195 total of 14.8 million barrels was du to the opening up of a new marke in California and to the expansion o existing markets in the State o Washington and in the Lakehead St. Paul area. These exports enable Canada to reach a position of two thirds self-sufficiency, on trade bal ances. Canada's dependence o foreign oil imports is equivalent t about one third of total demand.

Increase in Refinery Capacity

Self-sufficiency in crude supply fo practically all refineries within ec nomic range was a notable featur of 1956 operations. Completion of th lube manufacturing plant, which can supply nearly all the specialty demands formerly served by imports, and the opening of a domestic plant for production of tetra ethyl lead in October, were added steps towards placing the industry on a balanced footing.

Tar Sands

For thirty years the Federal and the Alberta governments and various oil companies have been carrying out research and testing methods of extracting oil economically from Alberta's enormous tar sand deposits in the Athabaska and Fort McMurray areas north of Edmonton. Had a natural supply of free flowing oil in Canada not been discovered, the tar sands would doubtless be in production now.

Announcement was made at the turn of the year that Royalite Oil Co. would develop the tar sands, variously estimated to contain oil reserves of 100 to 250 billion barrels of oil or from 25 to 60 times the proven reserves of free flowing oil in Canada today. Years of research had at last paid off.

Royalite will commence building a plant this coming spring to separate 20,000 barrels of oil daily from the sticky sands by a new centrifuge process. Later they will add a processing plant, a townsite for 1,400 people and a 350 mile pipeline to Edmonton. The initial cost is estimated at $50 million to be spent over four years.

In summary, the new year finds the oil industry in as healthy a condition as it has ever been since the big expansion following the Leduc discovery ten years ago. Great changes have occurred in the geographical distribution of oil production and marketing within the past year, with Manitoba and Saskatchewan taking a larger share of the market and showing a big share of the increase in production over 1955. The export market also showed a suddenly accelerated growth during 1956.

These factors promise to be even more influential in 1957 because of impending limitations on domestic growth, and because of the outlets created for production in southern Saskatchewan. There will be a redistribution of refining facilities in eastern provinces, due to a trend last year towards more growth in Ontario and less in Quebec. This is going to be felt towards the end of 1957 in the form of a small increase in the basic market for Canadian crude once the Interprovincial pipeline reaches the Toronto area.

All these developments and trends give promise of another record year of achievement in 1957, with good prospects of an attainment of a 6½ million barrel reserve and a producibility of 1½ million barrels daily by the year 1960.

NATURAL GAS

Production of natural gas in Canada has grown almost 3 times during the last 12 years to nearly 173.3 billion cubic feet in 1956. The total produced last year showed an increase of over 11½ per cent above 1955. The amount consumed in Canada, about 151 billion cubic feet, had shown a corresponding growth. Last year about 87 per cent was produced in Alberta, 7½ per cent from Ontario fields, 5 per cent in Saskatchewan, 1 per cent in New Brunswick, and a trace from the Northwest Territories.

At the end of 1955 there were some 450 Canadian municipalities or communities served with gas by some 47 distributing utilities, 385 of them were served with natural gas and the remainder with manufactured gas. Seven per cent of Canadian homes, or 27,000, were heated with gas, 63 per cent of them in the four western provinces and most of the balance in Ontario and Quebec. There were some 878,000 gas customers of all classes, 469,000 of whom or 53 per cent used natural gas.

Pipeline Battles Finally Resolved

Following the discovery of the huge Pincher Creek gas field in southwestern Alberta in 1947, many pipeline companies had sought incorporation and competed for the right to build pipelines to serve the most promising untapped markets in Pacific Northwest States and Canada's central provinces. Government indecision as to export policy at Ottawa, Edmonton and Washington tied the matter up for more than seven

Laying the Trans Canada natural gas line through the Great Sand Hills of western Saskatchewan. The 34-inch line is coated, against corrosion, and wrapped with fibreglass and kraft paper. In the background, the trench has already been back-filled. *(Photo: Trans-Canada Pipe Lines Limited.)*

years, during which little incentive to exploration for gas as such was carried out.

Finally in October, 1955, Federal Power Commission approval for the import of northern British Columbia natural gas to Pacific States was given, and a start was made on the 650 mile Westcoast Transmission pipeline to bring Peace River gas to Vancouver and inland British Columbia, and to connect up at the boundary with the Pacific Northwest Pipeline.

Then in June, 1956, following long and acrimonious debates in the House of Commons at Ottawa, approval was given Trans Canada Pipelines to build the western leg of its giant pipeline from the Alberta Saskatchewan border as far as Winnipeg. By the end of 1958, it will be serving Toronto, Montreal and cities and towns along the route, with Federal and Ontario governments building the 675 mile gap across Northern Ontario.

Meanwhile Trans Canada in 1954 had built an 80 mile pipeline from Niagara to Toronto and leased it to Consumers Gas Co. of Toronto to build up its gas market pending arrival of Alberta gas. Union Gas Co. of Chatham, Ont., obtained F.P.C. approval for import of an additional 15 billion cubic feet per year of U.S. gas to augment its supply and to build up its southwestern Ontario market until Trans Canada pipeline was completed.

Three- or Four-Fold Increase by 1965?

Completion of the Westcoast pipeline in the fall of 1957 and the expected completion of the Trans Canada project as far as Montreal by the late 1958 or early 1959 will release additional huge volumes of natural gas to thousands of eager Canadian customers, and to the rich untapped markets in Washington, Oregon and California. Export of Alberta gas to Minnesota and other mid-western States by Trans Canada via Emerson, Manitoba, is held up awaiting approval by the Federal Power Commission, pending the result of lengthy hearings in Washington.

Sales contracts in Canada by these two huge pipeline systems, added to the normal expected growth of consumption in Alberta and Saskatchewan in areas not dependent on the new pipelines for supply, may well double 1956 Canadian consumption by 1960 and increase it three- or four-fold by 1965.

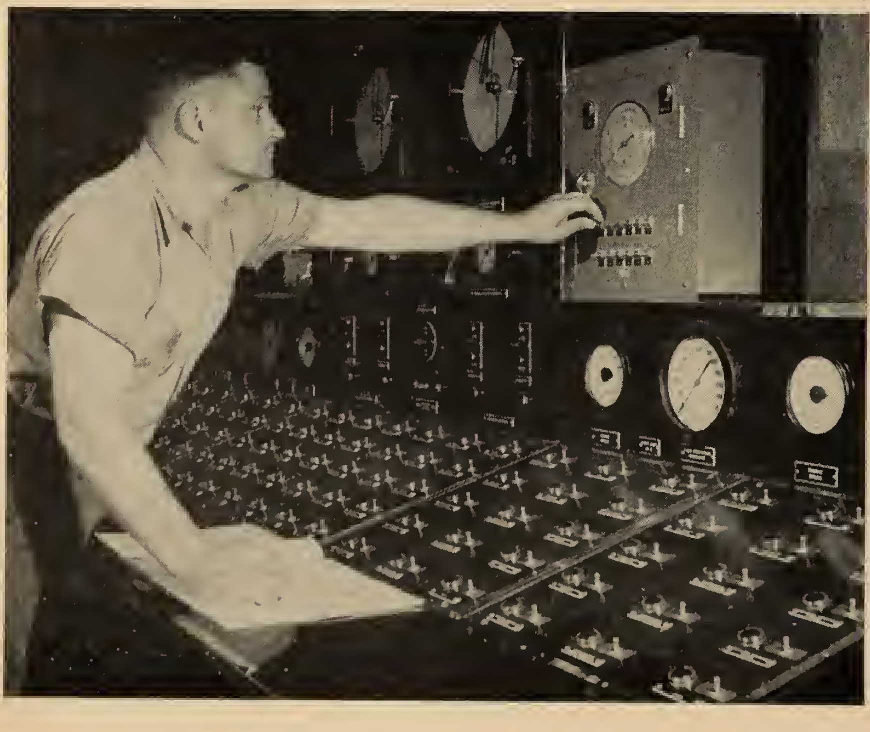
Where the Gas Will Go

Canadian sales contracts already signed with distributing companies and utilities by the two major pipelines now stand as follows: Westcoast Transmission will supply some 18 billion cubic feet yearly to Inland Natural gas in 1958, rising ultimately to some 29 billion cubic feet; British Columbia Electric will take some 19 billion cubic feet the first year, rising ultimately to 32 billion cubic feet.

Trans Canada will deliver a total of 103 billion cu. ft. to Canadian customers the first full year of operation, increasing to some 200 billion cu. ft. the fifth year. Broken down by areas, expected deliveries the first and fifth full years of operation respectively are estimated as follows: Moosomin to Swift Current, 4 and 4; Brandon to Portage, 3 and 5½; Winnipeg, 7 and 14; Keewatin to Port Arthur, 7 and 10; Port Arthur to Toronto, 13 and 26; Toronto, 24 and 48; Southwestern Ontario, 16½ and 28; Ottawa-Hull, 10 and 12; Toronto to Montreal, 4 and 7; Metropolitan Montreal, 15 and 42 (billion cu. ft.)

About 83 per cent of the gas from the Peace River fields will be exported to Pacific Northwest Pipeline Corporation; 9 per cent will go to the B.C. Electric Co. to supply the Vancouver area, while 8 per cent will go to Inland Natural Gas Co. which has franchises in practically all the communities in the southern British Columbia mainland. Initially, Vancouver is already receiving American gas from the San Juan Basin in New Mexico via Pacific Northwest pipeline. Ultimately the flow will be reversed and Canadian gas will flow southward as far as California.

At one of the sixteen stations that pump crude oil through the 1772 miles of the Interprovincial pipe line between Edmonton and Sarnia, an engineer checks the contents of a storage tank on an automatic tank gauge. (*Photo: Imperial Oil Limited*)



Impetus Given for Drilling

With construction of these pipelines under way a fresh impetus has been given for gas exploration and development. Though it is difficult to break down footage or completion figures accurately between oil and gas, drilling for gas was much more active last year by companies with acreage in Alberta gas fields earmarked to supply Trans Canada, such as Pincher Creek, Sibbald, Bindloss, Provost, Holmglen and others, owned largely by companies such as Canadian Delhi and B.A. Oil.

Activities of Pacific Petroleums in the past few years have chiefly been centred on search for gas in the Peace River district of northern B.C. and northwestern Alberta. A number of prolific fields have been discovered by Pacific Pet. and its associates in the region, most important of which is the Fort St. John field, where gas has been found in eight separate zones at potentials of up to 71 million cubic feet daily per well.

Ample Supply for Pacific States

Pacific's land holdings total over eight million acres, equal to 3½ million acres net to the company. Pacific's proven gas reserves alone total more than one trillion cubic feet of gas, though total reserves in the broad Peace River area have been placed at between 3½ and 5 trillion cubic feet. Westcoast's gas purchase contracts given it control over 2.35 trillion feet. They have also contracted for the output of the Savanna Creek field in the southwest corner of Alberta, owned by Phillips Petroleum Co.

Established Gas Utilities in Prairie Provinces

Apart from the Alberta gas fields whose production is earmarked for Trans Canada, Canadian Western Natural Gas and Northwestern Utilities, oldest established gas distributors in the west, have their own fields. Canadian Western, serving Calgary, Lethbridge and surrounding areas as far north as Red Deer, draws its gas supplies from its 775 billion feet of reserves in the Turner Valley; Jumping Pound and Nevis fields. It has storage capacity for 22 billion cubic feet in the depleted Bow Island field.

Northwestern Utilities, serving Edmonton, Jasper, Camrose, Ponoka, Lacombe and surrounding areas, draws from its 2 trillion feet of reserves in the Viking-Kinsella field. Late in 1956 the city of Medicine Hat commenced drawing gas from the newly opened Ezikom field.

In Saskatchewan, the Saskatchewan Power Commission supplies Biggar, Saskatoon and Prince Albert with gas from the Brock and Colville fields near the Alberta border. Moose Jaw is getting its supply from the Success field 120 miles west, built last year. The Saskatchewan Power Commission is seeking to import further gas from the Many Islands field astride the Alberta Saskatchewan border.

Texas Gas Building up Ontario Markets

In Ontario, two old established gas utilities are serving natural gas to their customers, namely Union Gas Co. of Chatham and Consumers' Gas Co. of Toronto. Union in addition to its own reserves in ten small fields in southwestern Ontario, purchases some seven billion feet yearly from

The Trans Canada natural gas line has 6000-lb. concrete weights attached to the 260-ft. section that crosses the Assiniboine river at Miniota, Man. ***(Photo: Trans-Canada Pipe Lines Limited.)***

other Ontario producers and imports some 16 billion cubic feet of U.S. gas from the Panhandle Eastern Pipeline Corporation. It serves 73 municipalities including London, Windsor, Chatham, and will, through a subsidiary, United Fuel Investments, serve the city of Hamilton.

Consumers' Gas of Toronto, up to February 1955 a distributor of manufactured gas, has now converted to distribution of natural gas imported from Texas and Louisiana through Trans Canada's 80 mile pipeline from Niagara. Its franchise area has been broadened to include metropolitan Toronto as well as communities east to Bowmanville, west to Clarkson and north to Newmarket. The company has a contract to take Alberta gas as soon as it becomes available.

Offshore Drilling in Great Lakes

A wave of interest in offshore drilling for natural gas commenced in a small way 14 years ago, culminated in great activity the past two years in the waters of Lake Erie, Lake St. Clair and Lake Huron. Here some 20 companies have exploration permits covering about 425,000 acres, most of it in Lake Erie. Some 50 or more wells, some of them as much as ¾ of a mile from shore, have been drilled and capped.

Consolidated West Petroleums, leading explorer in the field, has completed its 13th well. The field's reserves have not been made public by the company, but they are termed "sufficient to meet requirements of the contract with Union Gas Co., calling for 1.8 billion cubic feet in 1957".

Reserves Up

Total Canadian proven and probable reserves of natural gas rose from 21 trillion cubic feet a year to about 23 trillion cubic feet at the end of 1956. This resulted partly from continued search and development of oil fields and partly from an intensive and successful search for gas stimulated by the start of construction on the two major natural gas pipelines eastward and westward. Reserves are growing at an average rate of two trillion cubic feet yearly.

Petrochemical Industry Needs Gas (and vice versa)

The Canadian petrochemical industry is one of the fastest growing offspring of the boom in crude oil and natural gas production. With a history of two decades behind it and with production valued at $127 million for 1955, annual value of production is expected to double again within the next five years. So far, the bulk of petrochemical manufacturing has been done with oil products and their derivatives. In the United States, however, natural gas is the raw material base for about half of the entire petrochemical industry. Gas is already an important

Considerable additions were due at the Sarnia refinery of Imperial Oil Company, of which a view is shown here. These include a $25 million petrochemical plant and a detergent alkylate plant. A $30 million program was completed at the company's Halifax refinery during 1956. *(Photo: Imperial Oil Limited.)*

element in petrochemical plant operation in Alberta, the only prairie province where this type of manufacturing is done.

The versatility of crude oil as a raw material gives it a wide margin of preference over natural gas in petrochemical manufacture. Thus utilization of large supplies of oil products available at Sarnia and Montreal has made location of petrochemical plants most logical in those areas. Western natural gas is at present too distant to provide a supply at a competitive price.

Fertilizer plants at Calgary and Medicine Hat; a C.I.L. plastics plant, Canadian Chemical Co. Ltd.'s cellulose acetate plant; Polychemical Industries Ltd.'s plant, and Sherritt Gordon's nickel refinery, all at Edmonton; gas scrubbing and sulphur production plants operated by Shell Oil at Jumping Pound, by Royalite Oil at Turner Valley, and two more now under construction, by B.A. Oil at Pincher Creek and by Westcoast Transmission at Taylor Flats, B.C., as well as another projected by Inland Natural Gas in the Crow's Nest area; all these use vast quantities of natural gas from the western provinces.

The importance of these applications on the prairies is the availability of natural gas in the area where the markets exist. The major growth of markets, and of the manufacturing facilities to serve them, is bound to take place in the eastern provinces where the bulk of the population lives.

The place of oil as a sole source of fuel supply in eastern Canada will be partially displaced in future as gas becomes widely available there in 1959 or later in the large manufacturing centres.

REFINED PRODUCTS

With the addition of 112,000 barrels of refining capacity during 1956, Canada's total refining capacity for petroleum products at year's end totalled 708,000 barrels per day. During the first 9 months of 1956, total runs to stills of all types of refinery products showed an increase of some 18 per cent over production during the same period of 1955.

In 1955, the most recent year for which full statistics are published these refineries received 191.8 million barrels of crude oil, 55 per cent of it from Canadian sources and 45 per cent of it imported. Refineries in British Columbia used 17.3 million barrels; Alberta and N.W.T., 22.7 million; Saskatchewan, 18.7 million; Manitoba 7.5 million; Ontario 48.8; and Quebec and Maritime provinces 76.8 million barrels.

Of the Canadian crude supplies, 93.5 million barrels came from the Alberta fields, 5.9 million from Saskatchewan, 4.6 million from Manitoba, 0.56 from Ontario, and 0.4 from Northwest Territories. Of the 86.75 million barrels imported, 7.1 million barrels or 8.2% came from the United States, mostly from Texas and mid-continental fields, while 79.6 million barrels or 91.8% was oil from other foreign sources, 85% of it from Venezuela.

For the year 1955 sales of finished petroleum products by all Canadian refineries, in millions of barrels of 35 imperial gallon capacity, were as follows; aviation gasoline, 3.55; motor gasoline, 75.65; tractor fuel, 0.2; aviation turbo-fuel, 2.34; kerosene and stove oil, 13.26; diesel fuel oil, 15.56; light furnace oil, No. 2, 38.37; light fuel oil, No. 3, 1.59; heavy fuel oil, 43.19; asphalt, 7.22; coke, 2.16; lubricating oil and grease, 0.24; wax, 0.128; still gas, 0.19; other products, 0.39; liquefied petroleum gas, 2.87; feed stocks, 2.02; naphtha specialties, 1.3. Refinery losses amounted to 0.35 million, while unfinished products at year end stood at 5.2 million barrels.

POWER

PRODUCTION AND DISTRIBUTION

The Desroches and Bersimis dams of the Bersimis power development, in Quebec. The No. 1 plant was producing power in 1956, and construction had started on No. 2 plant.

THE YEAR 1956 was another busy one for Canadian power producers. More than a million additional horsepower, most of it hydro power, was added to the nation's installed capacity, which at the end of 1955 stood at some 19.4 million horsepower, both hydro and thermal in central stations, and for paper mills, mines, and other industries. Construction was also proceeding actively on other projects comprising over 1½ million horsepower to come into operation during 1957, and probably a further 2½ million or more during 1958.

As shown in Table I, Quebec was the leading province with more than half a million horsepower added, most of it due to the addition of the first three 150,000 h.p. units at Bersimis No. 1, followed by British Columbia with installations on several hydro projects totalling a quarter of a million horsepower. Hydro and thermal installations in Alberta, Ontario and Saskatchewan, in that order, were next in installed capacity added, while smaller additions

were recorded for New Brunswick, Newfoundland and Nova Scotia.

Total installed capacity of water power plants in Canada is now listed by the Water Resources Branch of the Dept. of Northern Affairs and Natural Resources at 18,356,148 h.p., while if thermal capacity is added, the grand total exceeds 20 million h.p. There are also several sites of high capacity presently under investigation on which development will be undertaken within a few years.

Capacity Due to Double in Another Decade

The demand for power in some parts of Canada is such that it indicates a doubling in less than 8 years. It is therefore safe to predict that the industry, if the present rate of growth continues, will add more generating capacity in the next ten or fifteen years than it has since the beginning of the twentieth century.

Although installed horsepower is generally accepted as the principal measure of the industry's accomplishments year by year, the building of main transmission lines, rural distribution lines and substation capacity also represent a large annual outlay, and construction on all of these proceeded at a vigorous rate during the past year. Central Electric Station expenditure for 1956 was forecast a year ago at $580 millions for capital plant and $55 million for repair, and these figures should be greatly exceeded during each of the years 1957 and 1958.

The Department of Northern Affairs and Natural Resources estimates the presently recorded water power resources of Canada are more than 29 million h.p. under conditions of low stream flow, and nearly 51 million h.p. at average flow. The latter figure permits a feasible installation of some 66 million h.p. Turbine installation at the end of 1956 totalled 18.36 million h.p., indicating that only some 28 per cent of available resources are developed to date.

Output of Energy

Another measure of progress for the electrical power industry is the kilowatt hours of energy produced yearly, as shown in the accompanying graph. Energy produced in 1956 amounted to some 81.7 billion kilowatt hours, 7.1% higher than the 76.3 billions produced in 1955, and almost a threefold increase over the 32 billion kwh. produced ten years ago.

In total, some 4,600,000 customers are at present receiving electric service, almost three times as many as there were prior to World War II. Approximately three quarters of the estimated 630,000 occupied farm dwellings were receiving electric service in 1956. Some 92% of Canadian households use electric power. Average annual consumption per residential customer in 1955 was about 3,300 kilowatt hours as compared with 1423 kwh. in 1939; or two and one half times per customer.

Supply and Demand by Regions

In British Columbia, Canada's fastest growing province, power companies are benefiting from the spectacular industrial expansion taking place there. Traversed by three mountain ranges and with a relatively heavy rainfall, the province looks to hydro to meet future demands for a long time to come. Some 850,000 h.p. is under construction and due for operation over the next two years, with close to another million h.p. planned for the near future.

On the prairies, Alberta is barely keeping pace with demand. Needs for power will double within the next five years. Saskatchewan depends entirely on thermal power, and by 1975 expects half its needs will be met with atomic power. Manitoba is placing its bets for the southern regions on steam stations, while planning to develop its vast hydro resources in the northern areas for extractive industries.

Ontario has almost reached the end of its major economic hydro reserves. By 1968, output of energy from thermal stations will almost equal output from hydro electric plants. By 1970 all the province's hydro resources will be developed.

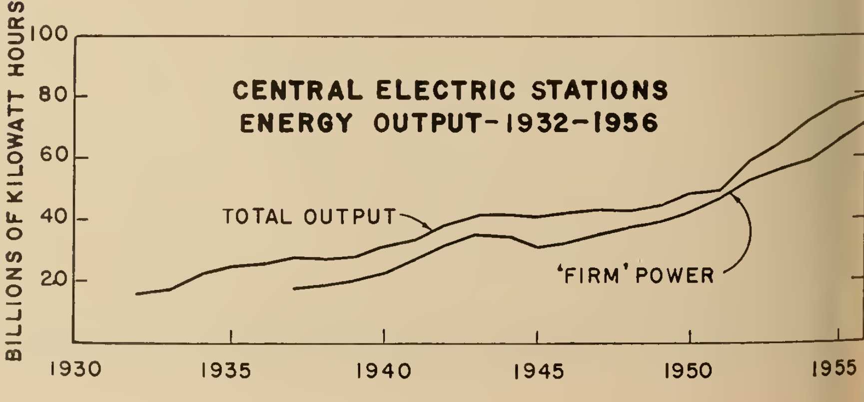
Quebec can meet all its growth needs until 1978 without thermal power. The province's huge hydro development program is keeping it well in front of all the others in total generating capacity.

In the Atlantic provinces, require-

Table I
Installations of Hydro and Thermal Power
(in thousands of horsepower and kilowatts)

	Installed 1956		Scheduled for 1958		Scheduled for 1959		Planned Future Additions		
	hydro h.p.	thermal kw.	hydro h.p.	thermal kw.	hydro h.p.	thermal kw.	hydro h.p.	thermal kw.	Notes
B.C.	245	...	463	69	150	134	519	36	(1)
Alberta	1	96	23	13	...	96	...	30	
Saskatchewan	...	42	...	...	...	...	19	...	
Manitoba	...	...	7	30	150	30	150	132	
Ontario	76	...	352	...	887	200	950	420	
Quebec	514	...	520	...	780	...	2520	...	(2)
N.B.	...	23	90	...	...	...	45	...	
P.E.I.	...	...	...	...	...	...	...	...	
N.S.	2	...	...	45	5	...	4	45	
Nfld.	8	10	13	...	1	...	18	...	(3)
Yukon-N.W.T.	...	...	...	...	15		880	...	(4)
	846	171	1468	157	1988	460	5105	663	

(1) Excluding Mica Dam and diversion of Columbia. (2) Excl. Lachine development. (3) Excl. 4 million h.p. Labrador. (4) Excl. 4 million h.p. Yukon-Atlin.

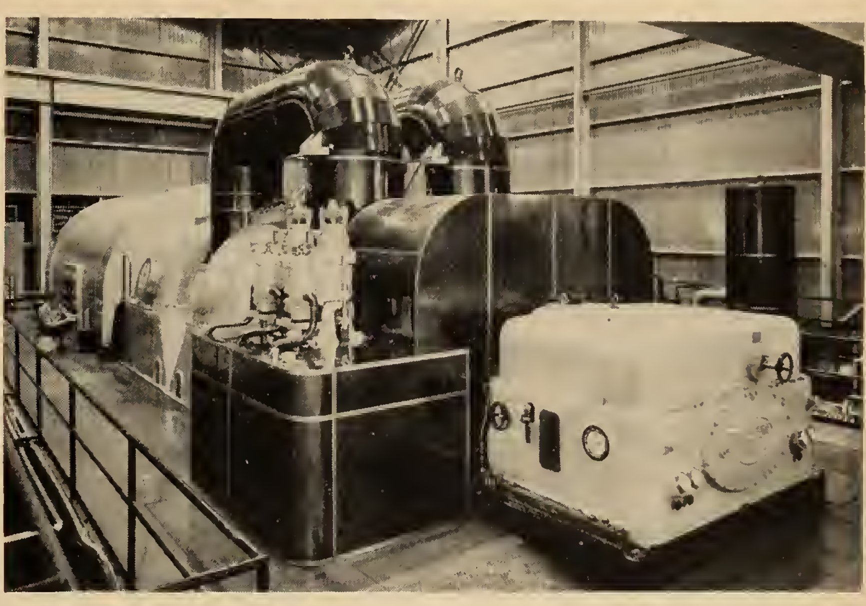


ments are increasing steadily, if more slowly, than elsewhere in Canada. Nova Scotia's hydro sites of any consequence are all harnessed and future additions will be thermal. New Brunswick has the Saint John river while potential of Fundy tides totals 3 million h.p. Prince Edward Island must depend on steam power. Newfoundland's hydro resources are large but remote and their development depends on attracting large extractive industries.

1956 Installation by Provinces

British Columbia — Major British Columbia developments in 1956 included a fourth 150,000 h.p. unit at Alcan's Kemano plant, with a fifth unit scheduled for operation in 1957. The British Columbia Power Commission installed a 35,000 h.p. unit at Campbell River, with a second unit due for 1957 operation. A 42,000 h.p. unit will come into production this year at the outlet of Upper Campbell Lake. A 35,000 h.p. development near Alberni is scheduled for completion in 1959. A third 16,500 h.p. turbine will be installed at Whatshan this year. Thirteen 3,000 kw. gas-diesel generating units will be installed this year at Quesnel, Dawson Creek and Prince George, as well as two 19,750 kw. units for a 100,000 h.p. gas turbine generating station at Chemainus.

The British Columbia Electric Co. completed its Seton Creek plant with installation of a 58,500 h.p. unit. At Lajoie dam a 30,000 h.p. unit will be completed in 1957. On the Bridge River No. 2 development four 80,000 h.p. units will be installed, the first three in 1959 and the fourth in 1960. On the Cheakamus development two 95,000 h.p. units are scheduled for service this year. At Clowhom Falls a single 40,000 h.p. unit is scheduled for operation late this year; a gas turbine plant with four 33,500 h.p. turbines will be added to the system in 1958. Other current developments in B.C. and the Yukon included completion by the Powell River Co. of its project on the Upper Theodosia river, which increased firm power output by 2,000 kw. Two 7,500 h.p. units are scheduled for 1958 installation at Whitehorse Rapids 1½ miles upstream from Whitehorse on the Yukon river, by the Northern Canada Power Commission. Northwest Power Industries had nearly completed surveys for design of an initial 800,000 h.p. development on the proposed Yukon-



EAST TO WEST

A sluice gate and part of the 3600-ft. canal for the Manuel's River development in Newfoundland. ***(United Towns Electric Co.)***

The 88,000 h.p. impulse type steam-turbine and generator of the Calgary Power Limited plant at Wabamun, Alta., uses natural gas as fuel.

Calgary Power Limited also started expansion to double output of the Cascade hydro-electric plant, near Banff. A 1845-ft. wood stave pipeline leads to the surge tank.

Atlin-Taku project, while surveys continued on the Nass river with a view to reaching the design stage late in 1956.

Alberta — Calgary Power Limited brought into operation its 66,000 kw. steam turbine plant at Wabamun, west of Edmonton, in 1956. A second unit will be in operation in 1958. At present fuelled by waste natural gas the plant is convertible to use of coal. The company is adding a second 23,000 h.p. unit to its Cascades plant, for completion this year. Investigations are also under way for adding 85,000 h.p. to its Spray and Rundle plants, doubling their present capacity.

Northland Utilities installed a 1,000 h.p. turbine at Jasper, while at the Fairview steam turbine plant another 3,000 kw. unit will come into operation in 1957. Canadian Utilities Ltd. brought into operation their Forestburg steam turbine plant with one 30,000 kw. turbine fuelled by strip-mine coal. The city of Edmonton will bring into operation two 30,000 kw. gas turbine units, one each in 1958 and 1959. City of Lethbridge will have another 10,000 kw. gas turbine in operation in 1957.

Saskatchewan — Saskatchewan depends entirely on thermal engines for power production. During the year a 33,000 kw. unit was added to its Saskatoon plant, a 6,000 kw. unit to its Swift Current plant and a 3,000 kw. unit to its plant at Kindersley. The Churchill River Power Co. is actively considering addition of a 19,000 h.p. turbine as a standby unit for its Island Falls hydro electric plant. The project is now in the design stage.

Manitoba — The Manitoba Hydro-Electric Board is building a steam turbine generating station at Brandon and will bring the first two 30,000 kw. generator units into operation late in 1957. A site at East Selkirk has been acquired for a new steam generating station with initial operation of two 66,000 kw. units by the fall of 1959. Interconnection of the southern Manitoba and northwestern Ontario distribution systems was effected in October 1956 to permit transfer of power.

The Board is planning a $30 million hydro development on the Nelson River at Grand Rapid to supply power for International Nickel's Moak and Mystery Lakes mining development located some 50 miles west of the power site. The plant will contain four or five 37,500 h.p. units with provision for three additional units. An early start on construction is contemplated.

The City of Winnipeg is continuing with renovation of its Pointe du Bois hydro electric station on the Winnipeg River.

Sherritt Gordon Mines, Ltd. is at present constructing its No. 2 development on the Laurie River, with one 7,000 h.p. unit to go into operation in October, 1957.

Grand Rapid, on the Nelson River in northern Manitoba, is the site of a new power plant for Manitoba Hydro-Electric Board which will supply power for International Nickel Company's Moak Lake development. (*Manitoba Govt. Photo*)

Ontario — The Ontario Hydro-Electric Power Commission, as responsible agent for developing the Canadian half of the 1,200,000 h.p. to be made available from the International Rapids section of the St. Lawrence seaway and power project, had made good progress and work was reported to be "on schedule" at the end of the year. Initial operation is scheduled for 1958, with all units to be in operation by 1960.

The addition of the final four units in the main plant of the Sir Adam Beck-Niagara Generating Station No. 2 was actively under way. At the pumped-storage generating station half a mile up the power canal six reversible pump turbines are being installed. When acting as turbines each unit will have a capacity of 47,000 h.p.

Ontario Hydro also has four projects in northwestern Ontario. At Manitou Falls on the English river four 18,500 h.p. units were brought into operation in July 1956. At Caribou Falls on the same river construction was commenced on a 102,00[illegible] h.p. development to contain three 34,000 h.p. units for operation in 1958.

At Whitedog Falls on the Winnipeg River 30 miles northwest of Kenora, preliminary work was started on an 81,000 h.p. development in three units, with initial operation scheduled for late 1957. In addition to these three projects, it is planned to add for 1958 operation a new 19,000 h.p. unit at Alexander Fall[illegible] and one of 25,000 h.p. at Cameron Falls, both plants being on the Nipigon river.

The Great Lakes Power Co., Ltd. is installing for early 1957 operation a new 30,000 h.p. unit in its Upp[illegible] Falls plant. Raising of the dam a[illegible] the site in 1956 had added 1,90[illegible] h.p. for two existing units. Activ[illegible] work will also be under way thi[illegible] year on a new plant at Centre Fall[illegible] where a 28,000 h.p. unit is sched[illegible]uled for 1958 operation. In easter[illegible] Ontario, the Gananoque Electri[illegible] Light and Water Supply Co. is in[illegible]stalling an additional 1,500 h.p. un[illegible] at its Jones Falls plant on the Ridea[illegible] Canal, for completion this year.

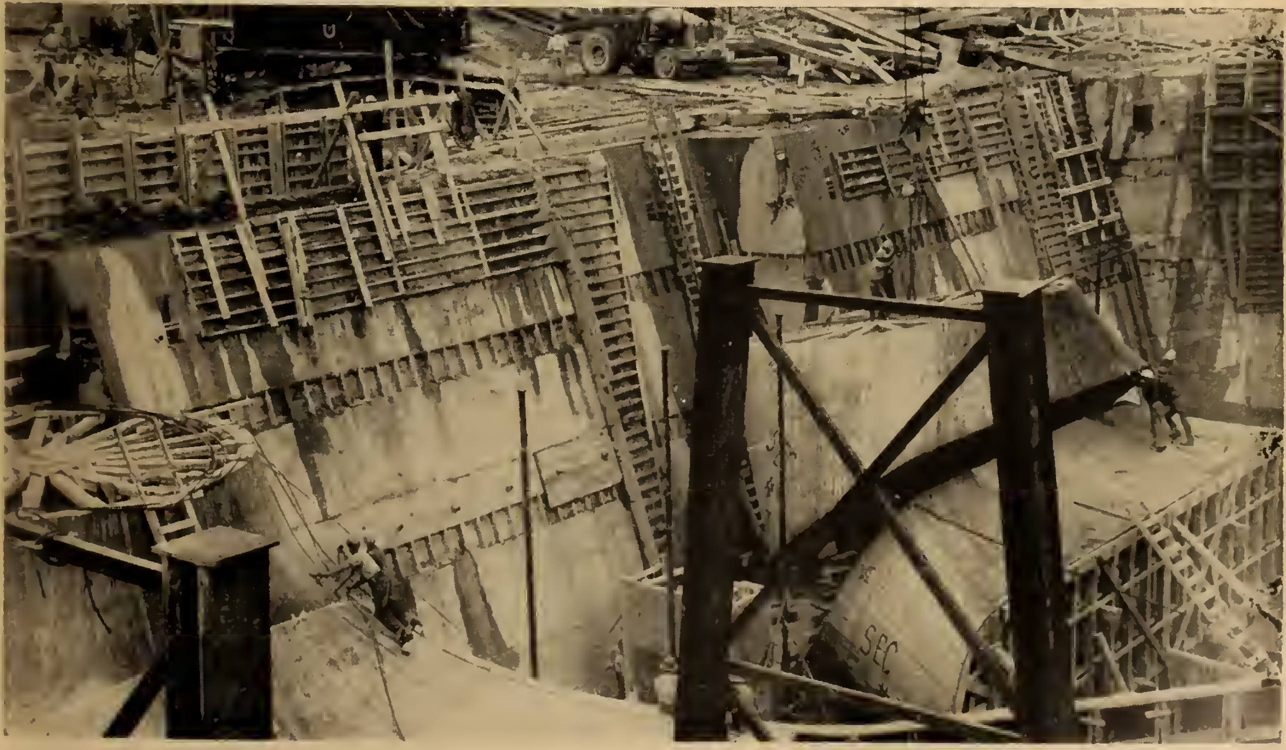
Thermal Stations — In collabor[illegible]tion with Atomic Energy of Canad[illegible] Limited, and the Canadian Gener[illegible] Electric Co., Limited, the Commi[illegible]sion is proceeding with constructi[illegible]

HYDRO ELECTRIC POWER

The underground tailrace chamber of the Bersimis power development is shown at the right. *(Photo: Hydro-Québec)*

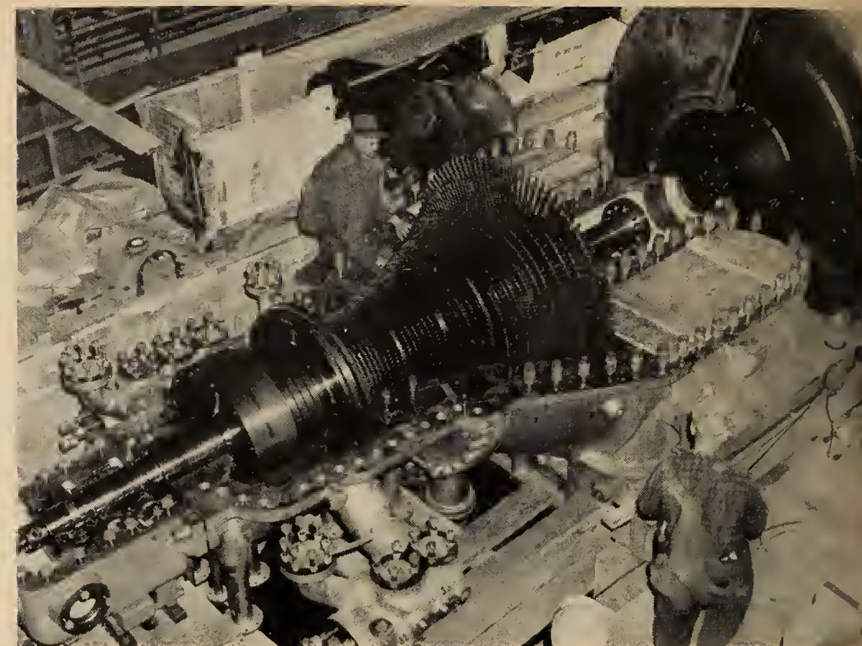
Excavation for the 1300-ft. by-pass channel at the Rapide Beaumont development of Shawinigan Water and Power Company (centre, left). Upstream from the powerhouse site, work proceeds on a new railway bridge, part of a nine-mile diversion of the main C.N.R. line (centre, right).

Lowering a section of the draught tube frames at the New Brunswick Electric Power Commission's Beechwood hydro-electric power development on the St. John River, 100 miles N. of Fredericton.



of a 20,000 kw. nuclear power experimental plant at a site adjacent to its Des Joachims' generating station on the Ottawa River. Initial generation of electrical energy is scheduled for 1959.

At the Richard L. Hearn generating station at Toronto, addition of a 200,000 kw. unit has been authorized for 1958 operation. Present expectations are that two similar additional units will be required during the next five or six years, bringing total station capacity to 1 million kw. Establishment of other thermal electric stations at centres of heavy loads elsewhere in the province is also being considered.



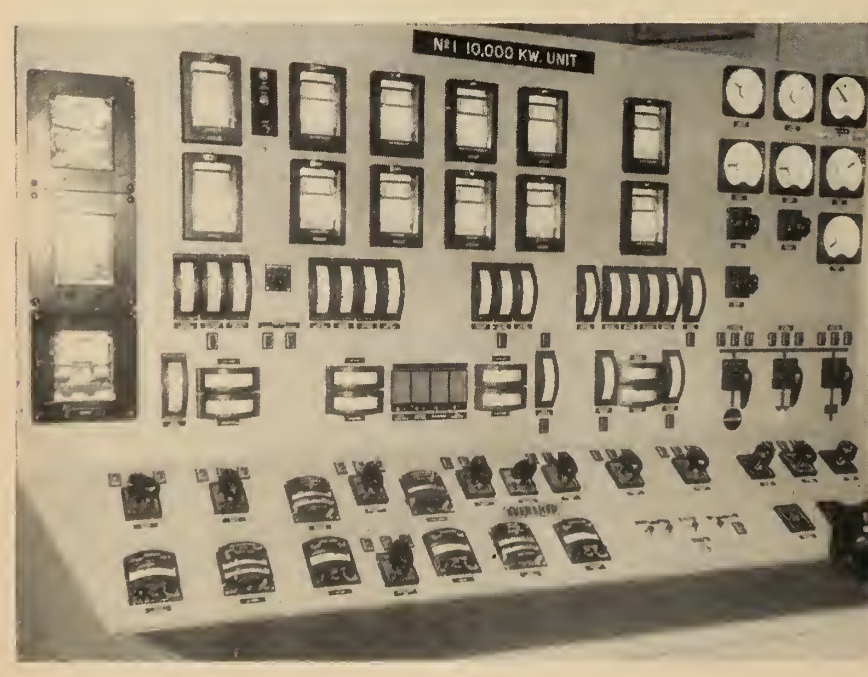
Quebec — Hydro-Québec brought the first three 150,000 h.p. units into production at its Bersimis No. 1 plant late in 1956. At Bersimis No. 2, some 23 miles downstream, preliminary construction was well under way at year end. This station will develop 835,000 h.p. in five units, bringing total installed capacity of the two Bersimis projects to 1,250,000 h.p.

At Beauharnois, enlargement of the intake canal by dredging was continued, and preliminary construction was commenced on the third and final section of the powerhouse comprising 11 units each of 65,000 h.p. It is expected initial operation will begin late in 1958, with completion of the plant scheduled for 1960 bringing the whole development to a total installed capacity of 2,150,000 h.p.

At its Rapide II plant on the Ottawa river a third 16,000 h.p. unit was added in 1956, with provision made for a fourth unit. Studies and surveys are proceeding towards development of the Lachine Rapids, while work is well advanced on a storage dam on a tributary of the Manicouagan river to allow a higher firm output from the plant of the Manicouagan Power Co.

The Gatineau Power Co. added another 47,000 h.p. unit to its Paugan Falls plant in 1956. Manicouagan Power Co. commenced work on its McCormick Dam Project No. 2, where three 60,000 h.p. units will be installed, one of them in 1957 and the other two early in 1958. The town of Parent, Que. installed a 1,300 h.p. unit in the first stage of a development on the Bazin river.

Other developments underway include Shawinigan Water and Power Co.'s 330,000 h.p. development at Rapide Beaumont with six 55,000 h.p. units, where initial development is scheduled for late 1958; Aluminum Company of Canada's 292,000 h.p. Chute des Passes project on the Peribonka river, where the first unit will operate late in 1957 and the balance in 1958; Price Brothers Co.'s 78,000 h.p. Shipshaw River plant, due for operation in October 1957; and Eastern Smelting and Refining Co.'s 42,000 h.p. plant on the Chicoutimi river which will be producing energy in June 1957.



Maritime Provinces — The New Brunswick Power Commission added a new 22,500 kw. unit to its Chatham steam station. Work continued at its Beechwood project on the Saint John river, where the first two 45,000 h.p. units will go into operation late in 1957 with provision for a third similar unit.

The Nova Scotia Light and Power Co. is expanding its Halifax steam plant, with one 45,000 kw. unit scheduled for operation this year and another similar unit to be added in 1959. The company is considering adding 5,000 h.p. to its Hemlock Falls plant for operation late in 1958. Replacements at this site last year added 2,250 h.p. Also under study is development of 4,000 h.p. on the Nictaux at Alpena.

In Newfoundland, Union Electric Light and Power Co. brought a

2,000 h.p. unit into production on the Trinity river last year. A second similar unit is under active prospect. United Towns Electric completed installation of a 5,600 h.p. unit at its New Chelsea development. The Maritime Mining Corporation will install 500 h.p. at its new Green Bay plant this year. Another 850 h.p. plant at Snook's Arm is under construction.

Bowater Power Co. Ltd. is constructing for operation in 1957, a plant on the Cornerbrook river with two 6,000 h.p. units. The company is also building a 6,600 kw. 50-cycle steam plant at Cornerbrook as a standby. The Newfoundland Light and Power Company Ltd. completed in 1956 the installation of an additional 10,000 kw. unit in its steam plant at St. John's. This company has under active prospect the construction of two plants at Rattling Brook near Norris Arm; the first rated at 13,000 h.p. and the second rated at 3,100 h.p.

In Labrador, the British Newfoundland Corporation completed investigations on the Hamilton river, which proved development of the power site at Grand Falls, one of the largest undeveloped sources of power in the world, is feasible.

Many Large Undertakings Under Way

Though space does not permit a detailed account of work carried out during 1956 on all of the many hydroelectric plants under construction, progress to date on some of the largest projects at present under construction is typical.

Beechwood — Construction of the New Brunswick Electric Power Commission's 90,000 h.p. development on the Saint John river got under way in the spring of 1955 following a two-year study of the power potential of the river basin by the International Joint Commission. By March last year eight of the dam's 11 piers had been completed with cofferdams removed to pass the spring floods. At year's end work on the main dam, powerhouse and other phases, was well ahead of schedule. Operation of the first two 45,000 h.p. units is scheduled for December this year, with provision for a third similar unit. The work is being done by contract, at an estimated cost of some $30 million.

Bersimis — On 16 Oct., 1956, the first commercial load of 50,000 kw. from Hydro-Québec Bersimis No. 1 plant at Labrieville, Quebec, was transmitted over the Commission's 300,000-volt power line to Charlesbourg, Quebec. By year end, three of the 150,000 h.p. units were in

THERMAL POWER

Installing the rotor in the New Brunswick Electric Power Commission's new 22,000 kw. unit at the Chatham generating station. (Top of p. 580.)

The first steam generating plant of the Newfoundland Light and Power Company Limited was a 10,000 kw. unit installed in 1956 at St. John's. An unusual feature is a new electronic system of boiler control, for which the control panel is shown (bottom, p. 580).

Steam plant of the Nova Scotia Power Commission at Trenton, in Pictou County, N.S., for which a new 20,000 kw. turbo-generator unit has been authorized. (Right, above.)

The Richard L. Hearn station of the Hydro-Electric Power Commission of Ontario (right) is the largest thermal station in the country, at present.

service. Commencing with preliminary construction in June 1952, Hydro-Québec had thus brought into operation one of the largest power plants in Canada within four years and four months.

The work involved a main dam half a mile long and 200 ft. high; another dam quarter of a mile in length; a diversion tunnel 1,000 ft. long, 39 ft. high and 36 ft. wide through rock; a concrete-lined main tunnel 32 ft. wide and 26 ft. high, 7½ miles in length; a surge tank 84 ft. in diameter, 680 ft. in height; eight 10 ft. diameter lined penstocks 385 ft. long; and an underground powerhouse cut out of solid rock, 565 ft. long, 65 ft. wide and 80 ft. high to contain eight 150,000 h.p. units.

In addition, a 300,000 volt transmission line comprising two double circuits to Charlesbourg and one double circuit from there to Montreal, and 400 miles long, was built to connect with the huge eastern interconnecting power pool at these points.

Three of the largest transformers yet installed in Canada, each weighing over 4 tons with oil, were placed in service at the Charlesbourg end. Electrical equipment also included the world's largest installation of 330 kv. disconnect switches, and the longest private commercial microwave communication system in Canada, linking Bersimis plants numbers 1 and 2, Forestville, Charlesbourg, and Montreal. Of the remaining five units, three will probably go into service this year with two to follow in 1958.

Manicouagan — Last November the Canadian British Aluminium Company Limited commenced construction of an aluminum smelter development at Baie Comeau, Que. The first stage of this four-stage $200 million project will be completed late in 1957, with the second stage going into operation by the end of 1958. The company is 60% owned by British Aluminum Co. and 40% owned by Quebec North Shore Paper Co. The new company also has a 40% interest in the Manicouagan Power Co., which will supply most of the hydro electric power to operate the smelter.

Manicouagan Power Company's output will be increased from its present 100,000 h.p. capacity to 250,000 h.p. at a cost of some $14 million. This involves an extension to its existing station at First Falls, the new undertaking being designated McCormick Dam Project No. 2. Plans call for installation of three additional units of 60,000 h.p. each. The present 69 kv. switching station is being extended and a new 161 kv. transmission line 10 miles long will be built to the smelter site.

Chute des Passes — The Aluminum Company of Canada began preliminary construction early last fall of a new hydro-electric development on the upper Peribonka river at Chute des Passes, about six miles downstream from the Passe Dangereuse Dam. The plant will take water frim the Passe Dangereuse reservoir through a tunnel about seven miles long, developing a gross head of 636 feet. Here an underground generating station will contain five 200,000 h.p. units, operating under a 625-foot head, the largest turbines yet installed in Canada.

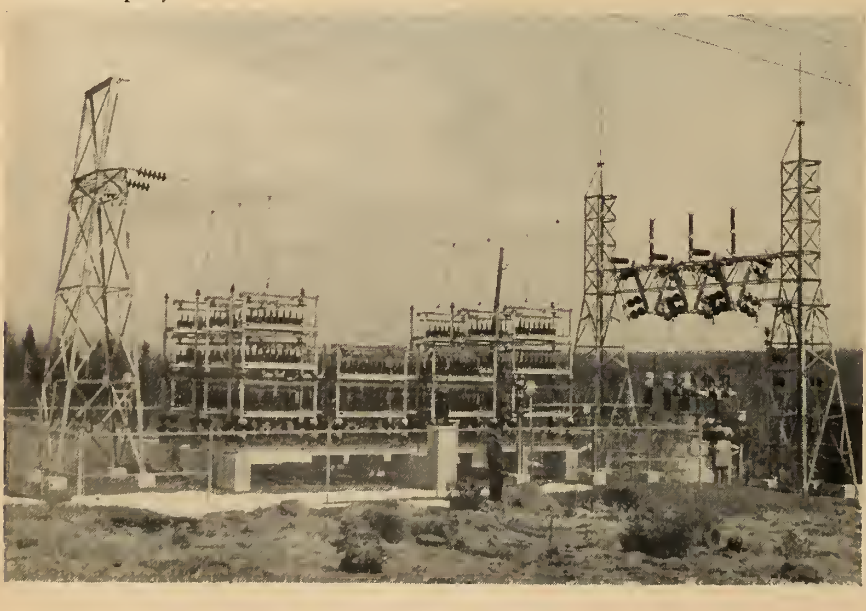
This project will add 700,000 firm h.p. to the Saguenay system as a whole, and will reduce chances of recurring power shortages. Initial operation is scheduled for 1959, with completion of the 1,000,000 h.p. development in 1960. A contract has been awarded to a joint venture group of contractors at a price of $135 million.

Beaumont-Shawinigan Water and Power Company made good progress at year end on construction of their Beaumont generating station upstream from La Tuque. Construction of camps, offices and living quarters was completed and some 450 families were living at the site, out of a total on-site force of some 1,200-1,400 men. All construction plant, including mining plant had been installed.

Work was proceeding on excavation of half a million yards of rock for the by-pass channel, and on cofferdams. Temporary diversion of the river flow will be undertaken early in the spring. The powerhouse will be of the semi-outdoor type, and will contain six 55,000 h.p. turbines operating under a 125-ft. head and driving 45,000 kva. generators. Initial operation is planned for the fall of 1958. An 87-mile 220-volt power line will be built to the Trois Rivières terminal station. Cost of the project including the transmission line is estimated at $56 million.

A 10-mile access road had been built from a new siding at Fitzpatrick.

A 9,000 k.var. 60,000 v. capacitor at Disraeli substation of Shawinigan Water and Power Company.



St. Lawrence Power Project — At year's end, work on the International Powerhouse had reached between 40 and 50% of completion. Progress on the two halves had been about equal at midsummer, but by year end the American half had forged ahead, reaching about 50% of completion with 450,000 yards of concrete placed, while the Canadian half stood at 38/40 per cent of completion. The Canadian half will catch up during the winter months while work on the American half is closed down. Installation of bedded parts for the turbines was under way on the Canadian half.

The first stage of the Long Sault dam was completed except for rollways and the entire flow of the river was gradually being diverted through the openings in the dam

)VER AND UNDER

'wo of the transmission lines of the ;ritish Columbia Electric Company Limi- ed span water by different means. \bove, the line to the Powell River de- elopment crosses Jervis Inlet, a span of 0,100 feet. Barges are carrying the able over to Nelson Island, up which an be seen the right-of-way for the line. 'he lower view shows a scow bringing a 32,000-volt cable from the cable ship)*cean Layer* to the shore of Galiano sland in the Strait of Georgia, part of he link between Vancouver Island and he B.C. mainland.

\hile the earth plug across Cut F ıpstream, already loosened by blast- ıg, became eroded as the rock fill cross the head of Long Sault rapids vas built up, diverting the flow and lrying the rapids.

The first stage of the Iroquois)am 25 miles upstream was com- ›leted except for rollways and al- ıost the entire river flow was pass- ıg through it as cofferdam cells ·ere rapidly closing off the Cana- ian half of the river.

Dredging for channel improvement ı the International Rapids and Thou- and Islands sections had been pro- eeding steadily and work on con- racts had passed the halfway mark nd were mostly on schedule. Clear- ıg on the islands was about 25% one. Tracklaying on the 40-mile NR main line diversion was com- lete and 75% of the ballasting done. ehabilitation of the Canadian area › be flooded was progressing rapid- / at the two new town sites.

Completion of all the heavy work \ the end of this year is forecast, ith flooding of the headpond heduled for midsummer of 1958 nd delivery of the first power ex- ected by September of the same ear. The channels and locks will be pen for the passage of ships in me for the opening of the 1959 avigation season.

Sir Adam Beck Generating Station o. 2 — This $344 million project, econd largest ever undertaken by)ntario Hydro and one of the orld's greatest, is now in the final ages. Currently in progress are the ddition of the final four 105,000 p. units, one scheduled for service te 1957, the other three in 1958.

At the pumped-storage generating ation, associated with the No. 2 ation and located half a mile up- ream on the power canal, six re- ersible pump-turbines are being in- alled. It is to make full use of the additional water provided by the pumped storage scheme that the aforementioned four units are being added in the No. 2 station.

An artificial lake or reservoir about two miles long and a mile wide will fill up during the night and off peak periods. In daytime when flow over the falls has to be increased, the compounded water is reversed through the pump turbine plant. Work was started in 1955.

At year end the reservoir dyke had been completed and concrete work was finished in the headworks and tailrace areas and for the first two units. When acting as turbines each unit will have a capacity of 47,000 h.p. under full reservoir head of 85 feet. Unit No. 1 will be in operation early this year and the other five each at intervals of about two months. The station is of the semi-outdoor type.

B.C. Electric's Bridge River System — The Seton Creek plant near Lilloet was completed last year with installation of one 58,500 h.p. unit under a 147-ft. head. At the La Joie Dam, construction is under way with one 30,000 h.p. unit scheduled to operate late in 1957. Work has commenced on the Bridge River No. 2 development involving a storage dam on the Bridge River, a second tunnel through Mission Mountain and a new powerhouse on Seton Lake about half a mile upstream from the existing plant. Here four units of 80,000 h.p. each will be installed for operation in 1959/1960.

Water for the La Joie reservoir will generate power at three different sites within the Bridge River system; at the La Joie plant, then at the Bridge River No. 1 or No. 2 plants and finally at the Seton Creek plant.

ATOMIC ENERGY

Any consideration of current developments in power production would be incomplete without noting briefly the important advances being made in the field of atomic energy. Its future use has been the subject of a vast amount of research by Canadian scientists, principally through the use of reactors at Chalk River.

This research is now taking concrete form for the first time in Canada on the upper Ottawa river where construction of a 20,000 kw. atomic power plant is under way by the Ontario Hydro, Atomic Energy of Canada Ltd., and Canadian General Electric Co. By means of this experimental undertaking known as N.P.D. (Nuclear Power Demonstration) it is hoped to prove the economic feasibility of nuclear plants, to obtain data on the economics of nuclear power production and to gain experience and train personnel for larger units in the future.

With the threefold increase in the demand for electrical energy predicted by 1975, inevitably a considerable number of additional installations will be in the form of thermal power and a growing proportion of these will be atomic.

While Ontario offers the best opportunities for utilizing atomic power in large units, the Maritime provinces as well will be increasingly dependent on thermal sources in the future, and nuclear sources will not be ignored. Even Saskatchewan, with its huge resources of petroleum and low grade coal, is watching progress in the field of nuclear power with interest. Smaller and isolated markets for atomic energy are probable in the high-cost power areas of the far north. The share of these markets that can be supplied from atomic sources is due for rapid growth when it is proved that nuclear power can compete with existing sources of supply.

Production of Canada's uranium ores is progressing rapidly in three major fields. 1957 production of some 125,000 tons is expected. To stimulate uranium production, Canada purchases the output of all acceptable concentrates offered, under a published price schedule effective up to March 1962. The bulk of current production is exported to the U.S. Atomic Energy Commission, though production may be retained for Canadian use when the need arises. There appears to be no doubt that Canada will have all the uranium needed for atomic power requirements for the foreseeable future.

Dr. A. J. Mooradian, Atomic Energy of Canada Ltd., in summarizing the research at Chalk River to date, states that uranium dioxide has been selected as the fuel for the N.P.D. reactor being built at Des Joachims on the Ottawa river. He also asserts that: (1) Economic fuelling of a power reactor to compete with present-day thermal power stations is possible. (2) The heavy-water reactor offers the best promise for achieving low fuel costs. (3) Practical limitation on achieving economic fuelling can be overcome, probably in the near future.

POWER IN THE NORTH

Plans were made in 1956 for the development of a new 15,000 h.p. hydro-electric station at Whitehorse, in the Yukon territory, for the Northern Canada Power Commission. This picture shows the early stages of construction and the de-watering of the cofferdam. (*Photo: Poole Construction Company*)

A tower in the micro-wave communication system linking the Bersimis No. 1 and No. 2 sites, Charlesbourg, Montreal, and Beauharnois. *(Hydro-Québec.)*

TELEPHONE

TELEGRAPH

RADIO

TELEVISION

COMMUNICATION

AND

TRANSPORT

RAILWAYS

HIGHWAYS

URBAN TRANSIT

WATERWAYS

PIPELINES

AVIATION

In 1956 scenes like this were seen no more in the west-end of Montreal, as streetcars were replaced by buses in a program of improved traffic engineering.

COMMUNICATION

NEW RECORDS were posted in 1956 for Canada's telephone industry, in capital expenditures, telephones installed and conversations. This is indicated by preliminary totals for the year based on records of the Bell Telephone Co. of Canada, which owns two thirds of the telephones in operation and accounts for 70 per cent of the employment by Canada's fifteen largest telephone systems, which together account for 91 per cent of the total for all Canada.

At the end of 1955 these fifteen systems had a total of 3,823,537 telephones in operation, eight per cent more than at the end of 1954. Cost of property and equipment at $1.41 billion was up 13 per cent from the previous year. Revenues at some $354 million exceeded the previous year by 11 per cent, while net income at $45.9 million was 7.6 per cent over the previous year. Conversations on twelve systems at 6.6 billion for 1955 exceeded the number recorded in 1954 by 11 per cent.

Record Year For Bell in 1956

In 1956, the Bell system's operating revenue rose by $29 million to $273.9 million or 12% over 1955. Net profit at $34.95 million was 9% higher than in 1955. During the year the company spent $139 million on construction of new facilities, or $10 million more than in 1955, bringing total assets to $1,183 million. The addition of 288,000 telephones raised the total installed by the company in its Quebec-Ontario territory to more than 2,766,000. This total was more than double the number installed up to ten years ago, and almost four times the number installed up to twenty years ago. Capital expenditure for 1957 is forecast at $176 million.

While the demand for new service continued to rise steadily in 1956, the company succeeded in reducing the list of waiting customers last year by 19,000 or 37 per cent. There remained at year-end some 28,000 unfilled orders for telephone service, as well as 47,000 unfilled orders for individual in place of party-line service. The number of exchanges had been increased, however, permitting individual line service as soon as ordered.

There was a sharp increase during the year in the demand for special services, including a wide variety of office and plant intercommunication systems. New fields of usefulness were developed for teletype, notably as a component of integrated data processing systems. Public services such as police and fire departments show increasing interest in the advantages of flexible communications systems tailored to meet their particular problems, and are being provided with special switchboards and private line teletype and mobile service networks.

Cross-Canada Microwave Network

Together with the other fourteen members of the Trans-Canada telephone system, Bell is building a 4,800-mile microwave radio relay network from Sydney to Victoria, including branches to Halifax, P.E.I., Moncton, The Soo, Saskatoon, Edmonton, and Lethbridge. During 1956 the Toronto-North Bay-Winnipeg section was completed, as well as part of the Maritimes sections. Construction of the remainder of the chain is progressing according to plan, and the entire network is scheduled for completion in 1958, to carry long-haul telephone conversations and provide network TV for 28 cities. This type of service has been in operation between Buffalo, Toronto, Ottawa, and Montreal for the last four years, connecting with telephone circuits and network TV all over the continent.

Network for Trans-Canada Pipeline

In co-operation with the rest of the trans-Canada telephone system, Bell is also building the communications network for control of the Trans Canada natural gas pipeline from Alberta to Toronto and Montreal. This project will knit together several communication services—private telephone lines, radio phones, and telemetering circuits—into a single integrated system.

Acting as agent for the Trans Canada system, Bell's special contract department has planned, designed, and built the mid-Canada radar warning line, which went into partial operation at the end of the year. Completion is scheduled for 1957.

Telegraphs and Cable Systems

Telegraph and cable systems operating in Canada had a record year in 1955, last year for which complete statistics are available. Earnings at $6.18 million were 49 per cent higher than for the previous year and almost 31 per cent above the previous record of $4.73 million established in 1943. Due to a decline in operating expenses, net revenues rose from $5 million in 1954 to $6.8 million in 1955.

New construction amounting to $9.66 million was reported for the year. The Dominion Government Telegraph Service, which sold the major part of its system in 1954, recorded a decrease in property and equipment of over $4 million. Western Union also reported a slight drop in its Canadian investment figure. All other companies showed increased investment and total cost of property and equipment at $124.3 million was 5 per cent higher than in the previous year. Pole line and wire mileages at 48,067 miles was higher than in 1954, largely due to an increase of some 1,900 miles in Newfoundland, and wire mileage rose to 438,692 miles. Employment rose slightly to 10,852 persons.

Telegrams transmitted at 20,067,424 were higher than in 1954 but below the peak of 21,815,800 reached in 1951. The number of cablegrams transmitted at 2,236,433 showed an increase of 6 per cent over the previous year. Money transfers established a new record with over $23 million transferred, almost 8 per cent above the previous high reached in 1953.

Overseas Telecommunication

Canadian Overseas Telecommunication Corporation was established in 1950 by the government (Department of Transport) to maintain and operate in Canada and elsewhere external telecommunication services for the public, by cable, radiotelegraph, radiotelephone, and other means between Canada and any other place, and between Newfoundland and any other part of Canada.

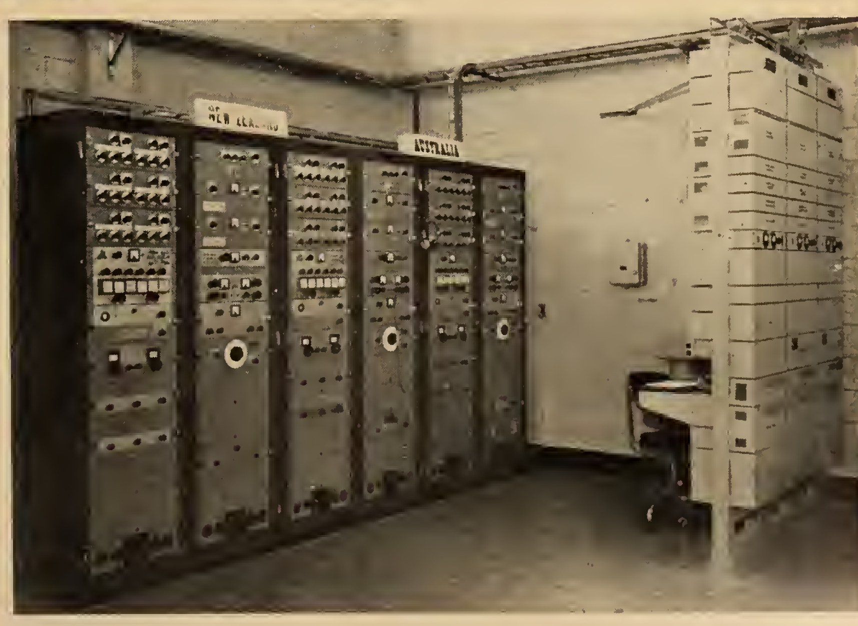
It would make use of all developments in cable and radio transmission and reception for external telecommunication service. Its objectives were the improvement of service generally and the coordination of

AT HOME

The second "4-A crossbar" installation in Canada went into operation in Montreal during 1956. Half the long distance calls in the Bell telephone system can now be dialled directly by the operators. This view is of the automatic trouble recorder associated with the installation.

ACROSS THE GAP

A high-frequency carrier system was installed by Canadian National Telegraphs during 1956 to bridge the gap between North Sydney, N.S., and St. John's, Nfld. The directional antennae at North Sydney are seen here.



OVERSEAS

Part of the installation at the Ladner, B.C., receiving station of Canadian Overseas Telecommunication Corporation. This is equipped with single side band receivers for telephone reception and special narrow band receivers for single side band telegraph. A micro-wave link with the transmitting station provides telegraph and telephone circuits.

The channel 9 antenna being removed from the CBLT tower, in Toronto, during the change-over to channel 6.

BROADCASTING

Electrical engineering and electronics are important fields in television communication. This view of the audio control room in Studio 42 of CBUT, Vancouver, also shows part of the visual control room through the window at left.

Canada's external services with the services of other parts of the British Commonwealth of Nations.

It was quickly apparent that increasing demands for overseas communications services from Canada called for the Corporation to embark on a program of expansion designed to meet anticipated requirements for the years ahead.

Perhaps the most important project under this program was Canada's participation in the transatlantic telephone cable jointly with the United Kingdom and the United States. After some months of negotiations, the Corporation on behalf of Canada, in November 1953, entered into an agreement for the construction and maintenance of a transatlantic telephone cable with the Postmaster-General of the United Kingdom and the American Telephone and Telegraph Company.

The laying of the first section of the cable started from Clarenville, Newfoundland, in June 1955, and the whole system was completed in August 1956. The cable was placed into service on 25 September, 1956. Total cost of the project amounted to some $40 million, of which the Corporation's share was about one-tenth. The quality of voice transmission and reception has been exceptional and public acceptance of this improved facility has been far beyond expectations.

The Corporation constructed a new headquarters building in Montreal (to which operations were transferred in March, 1957). Other recent developments include new trans-Pacific radiotelephone and radiotelegraph services to and from Australia to New Zealand. This required erection of transmitting facilities at Cloverdale, B.C., a receiving station at Ladner, B.C., and the erection of a two-storey building in downtown Vancouver. The new trans-Pacific operations commenced on 1 November, 1956, and for the first time Canada now has direct voice communications with Australia and New Zealand.

It also became necessary to augment overseas radiotelegraph facilities at Yamachiche and Drummondville, Que., owing to the expansion of existing services and the introduction of new direct radiotelegraph circuits between Canada, Germany, and France.

In December, 1956, the Corporation initiated and brought into service International Telex. This is an overseas teleprinter switching system by means of which the user can teletype directly from his own office into that of his correspondent. Service is made available across Canada by means of connections to the Corporation's International Telex switchboard in Montreal and provided by Bell Telephone Company, Canadian Pacific, and Canadian National Telegraphs.

Canadian Broadcasting Corporation

At the beginning of 1956 the Canadian Broadcasting Corporation had the following transmission facilities: radio broadcast stations, 22; frequency modulation, 5; low-power relay stations, 54; television stations, 8. Broadcasting on the International Service was carried out on nine frequencies with a power of 50,000 watts. In addition there were short-wave facilities for national service.

During the year a new combined studio and transmitter plant was constructed to replace the obsolete plant at Gander, Newfoundland.

Modifications were made to two existing television stations. The power of CBFT, Montreal, was increased to 100 kw. E.R.P. visual, 49 kw. E.R.P. aural, and the channel of CBLT, Toronto, was changed from 9 to 6, with power increased to 99.5 kw. E.R.P. visual, 53.9 kw. E.R.P. aural.

New television studios were built or additions made in Halifax, Ottawa, Winnipeg, Vancouver, Montreal, and Toronto.

Three variable frequency drive units were installed to facilitate frequency changes at the International Service transmitters at Sackville, N.B. Many other improvements and studies were made during the year.

RAILWAY TRANSPORT

ɴ Spite of the high level of busi-
ɪess and industrial activity in Can-
ıda during 1956, railroads have not
ɔeen sharing in the general pros-
ɔerity of the Canadian economy.
Though the volume of traffic has
ɔeen high, net financial returns have
ɔeen disappointingly low.

Over the first three quarters of he year 1956, revenue ton miles of reight, the main source of revenue or the railways, increased by some 2 per cent over the same period f 1955. The poor showing in net evenue, in spite of increasing traffic nd the 7 per cent rate increase uthorized last June, was due to apidly growing operating costs. Be-ides the increasing cost of materials, his was also due in large measure ɔ awards for wage increases.

Beyond this, however, it points to ıe need for relaxation of the obso-escent system of regulation by hich the railroads are governed, if ıe industry is going to be able to ıeet increasing competition and pro-ide the service which business, in-ustry and the public expect of it ı Canada's expanding economy.

Passenger traffic during the first ine months of 1956, on the other and, dropped below that of the ame period of 1955 by some 10 per ent. Here, regulation must share the lame with rapidly increasing com-etition from airlines, bus lines and ıe automobile.

anadian Railways in 1954

In 1954, the last year for which omplete statistics have been pub-shed, Canada's thirty railways had ,132 miles of single track, 31 miles ss than for the previous year. Their vestment in road and equipment nounted to $4,550 million. The ımber of locomotives in service ere 3586 steam and 1152 diesel, a total of 4771, compared with 19 in 1953. At the end of 1954 ere was a total of 189,351 freight rs and 6648 passenger cars owned. otal employment at 196,307 persons as 7.4% lower than the 211,951 per-ons employed in 1953; 60,000 of ese were transportation employees, mpared with 63,100 the previous ar.

During 1954, freight carried nounted to 143.2 million tons compared with 156 million in 1953. Locomotive miles operated totalled 160 million against 177.6 million in 1953. Fuel consumed (coal and oil) amounted to 10.3 million tons compared with 11.7 million tons in the previous year. Revenue ton-miles at 57.55 billion, compared with 65.27 billion the previous year. Revenue passenger miles amounted to 2.86 billion (2.98 billion in 1953). Gross earnings in 1954 were $1,019.5 billion; net earnings at $75.9 million were down from the total net of $105.5 million in 1953.

Canadian Railways in 1956

Though up-to-date figures are not yet available for all the Canadian railways, it is possible to record a substantial measure of Canadian rail operations for the year just passed from statistics of Canadian Pacific and Canadian National, which between them account for about 90% of the nation's railway traffic.

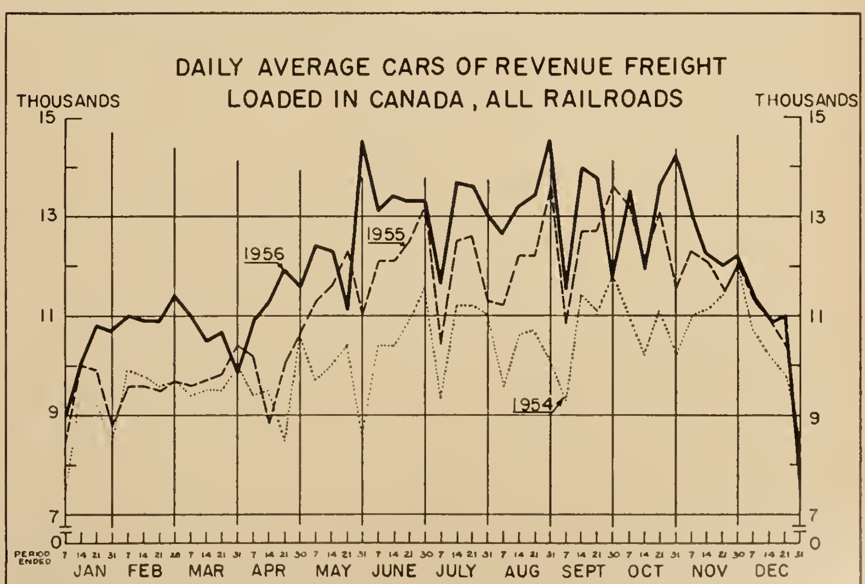
As of June 1956 there was a total of 180,411 railway-owned freight cars on all Canadian railways, of which 7,000 were undergoing repairs. There were also 15,170 privately-owned freight cars.

Canadian National Railways

Canadian National hauled about 12% more freight in 1956 than in the previous year, and record earnings will be reported. Freight traffic, its main source of revenue, is heavily weighted with raw materials which move on low rates. Despite the interim 7% rate increase last July, average revenue per ton-mile continues downward. The further 4% increase to become effective for 1957 on 1 January will still fall short of meeting the full impact of 1956 wage awards.

Equipment. More than $95 million was invested in cars and locomotives during the year. Deliveries of new rolling stock included 324 diesel locomotive units and 4633 freight cars. Two new types of car were introduced for specialized traffic. These are a pulpwood car that increases normal carrying capacity by 70%, and a double-decked automobile transporter that can load eight standard size automobiles compared with the normal four. These, together with an all-purpose box car, are under tests. Orders were also placed for 6110 freight cars and 130 air-dump work cars.

The year saw completion of a five-year plan to dieselize much of CNR motive power. The $220 million spent has resulted in substantial economies. Further development of this plan is contemplated on a territorial basis, commencing at the eastern and western extremities of the system. In Newfoundland 26 diesel units were delivered in November, where complete changeover to diesel motive power is now close to realization. Experiments with motive power were continued. After summer tests in 1956 on a diesel locomotive equipped with hydraulic transmission it is being



observed for winter performance in western Canada.

Operation and Maintenance. For railway track maintenance the company spent some $3 million in continuation of the program for mechanizing track work. Another 140 miles of automatic block signals were added to the 480 miles already installed. The signalling and switching system known as CTC, (centralized traffic control) has raised train speeds and increased traffic volume about 90% without adding physical track. In 1956 the company was able to remove 40 miles of track by applying CTC. There are now more than 700 miles of CTC on Canadian National lines.

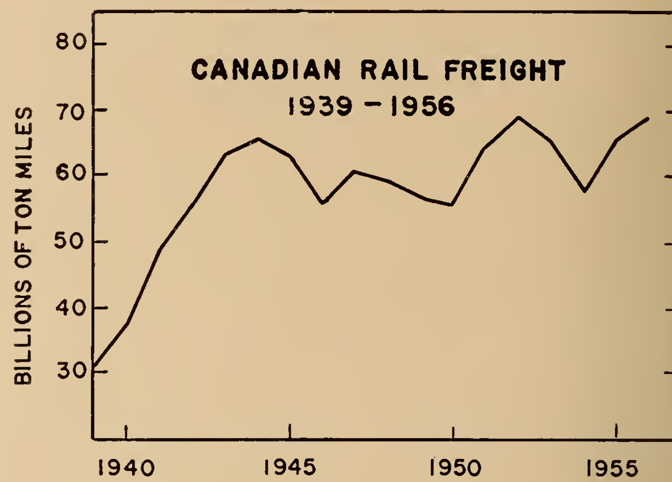
The east-west run of Canadian National's 'Supercontinental' was reduced by 40 minutes and a new 6½-hour mail train was placed on the Montreal-Toronto run. Dinette cars and coffee shop service with popular prices have been well received. Five more dinettes are on order for 1957 delivery.

During the year an entirely new communications service, known as 'Telex' was offered to subscribers. It provides instantaneous two-way written communication between Canada, the United Kingdom, and Europe. It will be extended to other parts of the world in 1957.

Ocean Service. Canadian National Steamships added San Juan, Puerto Rico, to its ports of call during the year, and calls were made in Cuba as warranted. All eight of the vessels in the CNS fleet are now equipped with refrigerated chambers. Fifty-six voyages were made during the year. The motor vessel *Bluenose* commenced operating in August between Yarmouth, N.S., and Bar Harbor, Maine. CNS operates the service on behalf of the Canadian government, and over the first two months of service it carried more than 60,000 passengers and 1,600 vehicles in the daily round trip service.

Construction. Turning to construction, work continued on the company's new Queen Elizabeth Hotel in Montreal, with all but the top three floors closed in at year's end. The hotel will open in 1959. Clearing and grading was commenced at the site of a new automatic hump yard on the outskirts of Montreal.

Elsewhere, a 40-mile diversion of the CNR double-track main line from Montreal to Toronto, between Cornwall and Cardinal, had been built and will be ready for operation in summer 1957. Most of the abandoned section will be flooded a year later, when power from the St. Lawrence is turned on. In Quebec, a 290-mile line from St. Felicien to Beattyville is being constructed through the Chibougamou mining fields, with the track in a usable condition as far as Opemiska at year end.



In New Brunswick, a 22-mile line was cleared and graded through the forest from Bartaboq to serve a new mine site. In Manitoba a route had been surveyed from the Hudson Bay Railway into the Mystery-Moak Lake district to serve International Nickel's new $175 million copper-nickel project, and construction was already under way.

$80 Million Added to Payroll. The cost of wage increases aggregating 11% over the term of a two-year agreement, and a health and welfare plan effective 1 January, 1957, for non-operating employees have to be met following an award made during 1956. This and other awards will add some $80 million to Canadian National's annual expenses. Parallel benefits have been made available to employees not covered by wage agreements.

Canadian Pacific Railway

As was the case with the Canadian National, traffic volume in 1956 for the Canadian Pacific was high and rising, but financial returns were low. The return on net railway investment in 1956 was only some 3.2%, substantially less than earnings in other industries and even below the current return to the investor in many issues of Dominion of Canada Bonds, with their risk-free security.

At mid-1956, the company's rolling stock included 2,000 locomotive units, 80,000 freight cars, 3,000 passenger train cars, and over 6,000 units of work equipment. Investment included an item of $749 million for "rolling stock, steamships and 8 hotels" and another of $199 million for "other properties".

At that time CPR president N. R. Crump told shareholders that during the next 15 years the company would have to meet capital requirements of $1.5 billion, or an average of $100 million yearly. These expenditures would include: for dieselization, $135 million; for renewal and expansion of railway plant, $600 million; for new freight equipment, $480 million; for new passenger equipment $45 million; for new work equipment, $15 million; for hotels, $28 million; for possible construction of a large ship, $22 million; for cargo ship replacement, $28 million; for communication services, $60 million; and for Canadian Pacific airlines $60 million.

Much of the money required, h[e] said, would have to be raised a[s] new capital. Not much more tha[n] $60 million per year would be avai[l]able from depreciation accruals an[d] salvage proceeds. Of the remainin[g] $40 million a year part might co[me] from retained earnings, but much [of] the funds required would have [to] be raised as new capital, and som[e] equity financing would undoubtedly be necessary.

Equipment Modernization. In co[n]tinuation of its modernization and ex[-]pansion program during 1956, Cana[-]dian Pacific placed 115 new dies[el] units into service, bringing to 670 the number of units in operation. Additional high-speed self-propelled diesel operated "Dayliners" were also placed in operation in Nova Scotia on the Dominion Atlantic Railway. They also made their appearance on the Montreal-Boston run, between Montreal and Sutton, between Toronto and Owen Sound, and on Sudbury-Fort William and Moose Jaw-Calgary runs.

A total of 31 of these units were in service at year-end, with a further 11 on order for delivery this year. Some 4,000 freight cars were also added in 1956.

Buildings and Hotels. An extension to the Royal York Hotel, at Toronto, costing some $10 million, was started during the year, to bring its total capacity up to 1,600 rooms, making it the largest hotel in the Commonwealth. Completion is expected for December 1958. A seven-floor open deck 400-car parking building will be added adjacent to the hotel, primarily for hotel patrons. A contract was signed for a new $375,000 office building at Vancouver airport, to serve as a centre for Canadian Pacific airlines $20 million Bristol Britannia expansion program. Completion is scheduled for early this year.

Additions to CPS Fleet. Canadian Pacific's modernization and expansion program was highlighted last year by the entry into service of the 25,000-ton *Empress of Britain*, flagship of the Canadian Pacific Steamships' fleet on her maiden voyage. The company's newest addition to the CPS fleet, *Empress of England*, was launched at Newcastle-on-Tyne in May. (First sailing from Liverpool, April 1957.)

The *Empress of Scotland*, now on North Atlantic cruise service, will reach retirement age in some five years, and purchase of a third new ship, probably of greater tonnage than the *Britain* or *England*, is being considered.

$20 Million Program for Airlines. Canadian Pacific Airlines placed orders for 12 more DC-6B Empress airliners. Four were delivered in 1956, four more are scheduled for delivery in 1957, and the remaining four will be in operation in 1958. CPA last year also undertook a $20 million expansion program to bring a fleet of long range Bristol Britannia turbo-prop aircraft into service on its five-continent airline system. The first five will be delivered in 1957.

Office and Communications Equipment. First deliveries of new yard office and freight office equipment for automatic recording of source data, designed to CPR specifications and first of their kind in use anywhere, were being placed in operation as deliveries were made. The extensive communications network which links this IDB system together was nearing completion at year-end.

The integrated data processing program for streamlining accounting and other railway paper work, begun in 1955, was going forward. Rapid conversion from traditional procedures took place in nearly all departments. The installation at Montreal headquarters of a large electronic computer, equipped with memory core, was also progressing, and operation on an expanding scale was effected early in 1957.

An international teleprinter exchange service from Canada to over 30 countries was completed in 1956 as a joint project with Canadian National; this should be most helpful to Canada's world trade.

PGE Reaches Vancouver

An important event in the annals of Canadian railroading took place on 11 June, 1956, when the Pacific Great Eastern completed its 25-mile extension from Squamish, B.C., the previous southern terminal of the line, into North Vancouver. This extension overcomes the need to ship by ferry to Squamish to connect with the Squamish-Prince George line. The extension was undertaken in 1954 and now provides a system equipped with radio communication between Vancouver and all trains. Currently, a further 330-mile extension north of Prince George is under construction with termini at Fort St. John and Dawson Lake.

TRACK MAINTENANCE

The metal hands of this multiple tie tamper are designed to tamp rock ballast firmly into place around and below the wooden ties. The railways spent large sums of money during 1956 on construction and maintenance machinery. *(Photo: Canadian National Railways.)*

HIGHWAY FREIGHT

COMPILATIONS of statistics relating to the movement of freight carried over Canadian highways on a national basis, commenced in the mid-forties, has to date fallen far short of being a complete coverage. Continued cooperation of provincial authorities and trucking associations is bringing gradual improvement, but much still remains to be done. Since little capital is required to enter the trucking business, many marginal operators are associated with the industry. The large turnover and numerous changes in operators each year creates many problems in the collection of records.

For example, mergers, business failures, the necessary discarding of unsatisfactory reports, inadequate descriptions of business operations, and often lack of maintaining records of tons hauled, have made it impossible to compare reports with those of prior years without adjustments.

In 1954, the most recent year for which a complete annual report was issued, 2411 freight carriers owned or rented revenue equipment consisting of 8455 trucks, 6343 road tractors, 8034 semi-trailers, and 895 full trailers. Operating revenue totalled $181.5 million, and average employment during the year was 20,284 persons.

Tons of freight carried totalled almost 27 million tons. Ton miles were not reported, thus a realistic comparison with rail freight traffic is not possible. From a comparison of tonnages hauled by highway and rail, however, it would appear the highway freight movement amounted to about one sixth of the rail freight moved.

Sample Surveys Being Conducted

Over the past two years, the Dominion Bureau of Statistics, with the cooperation of provincial authorities, has undertaken sampling surveys on highway transport with a view to obtaining more complete and accurate data. To date, results of these surveys for the provinces of Manitoba and Ontario have been published, including the volume of freight carried on both highways and streets. Sample surveys are now being carried out in all other provinces and annual reports will follow until traffic statistics can be produced annually for all Canada.

As a measure of the limited coverage of highway transport operations up to and including 1954, Ontario freight-carrying motor vehicles of all types reported that year added up to 11,365. Freight carried for the year was shown as 10½ million tons. In the sample survey for Ontario in 1956 replies to questionnaires indicated a total of 251,679 trucks registered in Ontario, which carried 142 million tons of goods. Total ton miles amounted to 9.81 billion.

Sixteen Per Cent of Freight Haul by Truck?

In 1954, highway freight carried in all provinces was recorded as some 2.4 times the total for Manitoba and Ontario. Assuming the same ratio maintained in 1956, when the sample surveys were conducted, a similar sample survey for all provinces would have shown some 400 million tons. This total multiplied by the weighted average distance each ton was hauled in Manitoba and Ontario of 30 miles, would indicate some 12 billion ton-miles of highway freight haul for all provinces in 1956. Comparing this with the 74 billion ton-miles of rail freight for the same period would suggest railways may carry about six times as much freight traffic as is handled by motor vehicles of all types in cities and on highways. Expressed in another way about 16% of the entire freight movement in all Canada is possibly handled by motor vehicles.

Industry's Prospects are Excellent

John Magee, executive secretary for the Canadian Trucking Associations of Canada, told the Canadian Manufacturers' Association convention at Toronto in June 1956 that Canada had 69,500 "for hire" trucks engaged in the intercity and rural freight movement, out of a total of 869,000 trucks of all kinds. By 1980, he predicted, this "for hire" fleet would be expanded to more than 156,000 units.

Decentralization was likely to continue, he pointed out. Small centres and light industries form the most important markets for highway freight service. The demand for trucking services would increase proportionately with the growth of these new markets. Automation would increase the need for an even and fully controlled flow of parts and materials, creating a demand for quality transport service.

But some of the industry's problems were the result of factors responsible for its very growth, said the speaker. Wages in the trucking industry would show a tendency to increase faster than the national average. A considerable overall increase in productivity per worker was essential if the industry were to continue to price itself within the market. If the trucking industry's wage bill increases by 30%, the ton-miles carried per employee must increase by 45%, he warned, to reserve its competitive position vis-a-vis other forms of transport.

In many parts of the country the state of the highways had put a severe limitation on the application of technological progress to vehicle construction, said Mr. Magee. Loss of time due to traffic bottlenecks had in many instances been more serious than the savings of time obtained through safe speeds on the open road. Growing importance of international freight movement by trucks made further careful planning of customs clearance facilities and inland sufferance warehouses imperative.

There was little interest among truck operators in immediate use of two-way radio, but there was a rapidly decreasing supply of frequencies. Unless the industry soon reserved frequencies, there would be none left when needed, he warned.

The average outlay per truck had increased by an estimated 50% to 75% over the past ten years. Other capital outlays had increased more than proportionately. In order to maintain the industry's competitive position, the speaker predicted the capital invested per worker would have to increase by 50% over the next decade.

The Automotive Transport Association of Ontario took a searching look at itself at its convention last November. Though delegates foresaw continued growth, they also saw many problems ahead. There was a lack of reciprocal licensing deals which would allow trucks to cross border freely. Average gross revenue per truck in the "for hire" category was only $12,000 per year. Canada lagged behind in the development of trans-continental roads. However, cargo loss and claims damage was better than U.S. coverage and lower tha ail figures. Proper training and licensing was the best way to reduce driving hazards.

Regulation of Motor Vehicles in Inter-Provincial Operation

Regulation of vehicles operating across provincial borders is a controversial subject. After the Imperial Privy Council ruled that such regulation was within federal, not provincial, jurisdiction, Parliament passed legislation giving effect to the judgment but turning regulatory powers back to the provinces on a trial basis.

A conference of provincial representatives at Toronto in September 1956 to discuss the situation failed to arrive at any decision on how to effect uniform regulation.

There is a growing belief within the industry that federal control of interprovincial carriers will soon replace provincial regulatory authority, unless there is immediate action on the part of the provinces towards unification of motor carrier regulations. The need for uniformity is greater now than at any other time in the history of Canadian motor transport.

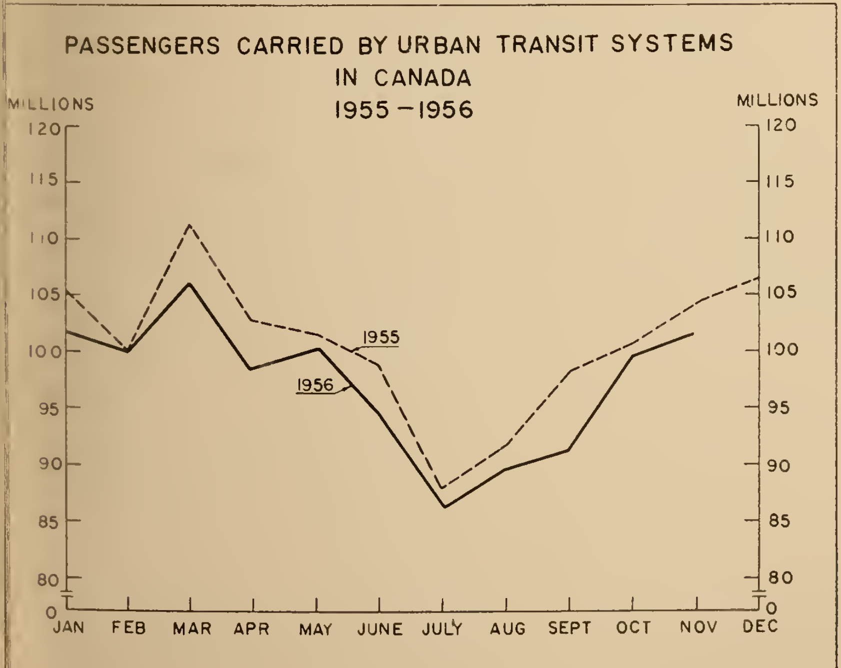
URBAN TRANSIT

EVERY YEAR since 1945 Canada's urban electric railways and their urban motor bus and trolley coach lines have carried fewer passengers than in the previous year. The cumulative drop over the last decade adds up to about a 20% decrease.

In an effort to arrest this creeping paralysis and to keep solvent, the various transit systems have raised fares more than 20%. But with operating expenses mounting yearly for a cumulative rise of more than 40% over the same period, the fat net operating revenues enjoyed during the war years have now practically disappeared.

Statistics for the first 11 months of 1956 indicate the downward trend in passengers had continued for all provinces with the exception of British Columbia. Gross revenue was up some 10% for all Canada, up 19% in Quebec cities, up 14% in Ontario cities, up 10% in British Columbia, and down in cities of all other provinces. Similar trends in transit traffic have been experienced in most cities in the United States.

At the end of 1954, the last full year for which records have been published, 21 transit properties across Canada owned 2,128 electric cars, 56 electric locomotives, 1,144 trolley coaches, 2,348 motor buses, 224 trucks, and 368 express, freight, and miscellaneous vehicles. Total employment for the industry stood at 20,318 persons. By the end of 1956 the number of electric cars was sharply lower while the number of motor buses had been correspondingly increased.



Trend From Trams to Buses

The shift from electric railway to bus operations is illustrated by the fact that over the past 30 years some 43 electric railway systems have ceased operating as such. The convenience of operating over a 'right-of-way' maintained by the municipality or province, combined with the greater manoeuvrability inherent in a free-wheeling vehicle, have encouraged this transformation in transit operations. In 1946, 19% of passengers carried were moved on motor buses and trolley coaches. By 1954 this percentage had risen to more than 55% and the trend was continued in 1955 and 1956 with nearly 75% carried by trolley and motor coaches during the past year.

Solution for Congestion

Addressing the 51st annual meeting of the Canadian Transit Association in May, 1956, C.T.A. president S. E. Preston described Transit's predicament in part as follows: "A solution of the problem of how to provide adequate facilities for the speedy, safe, and economical movement of people in Canada's booming urban areas must soon be found if our cities are to remain desirable places to live and work and do business. Within the next quarter century many of our larger cities will double in size and some may increase threefold. This means transit service will become even more vital than it is today . . ."

"Traffic congestion created by the convenience of the automobile, is the core of the problem. The fact that what has been done to correct the situation is not nearly enough, is generally acknowledged. In the past five years large investments in modernization have failed to pay off, simply because the new vehicles have not been allowed to accomplish the intended purpose through increased scheduled speed. Transit riders have become motorists, and the squeeze on the streets creates a financial squeeze for transit operations . . ."

Outstanding developments during 1956 included a change-over from streetcars to buses in the west end of the city of Montreal last September, and a cessation of operations by the Montreal and Southern Counties' Railway last October.

Interurban and Rural Bus Lines

At the end of 1954, last year for which complete figures are available, there were 298 passenger carriers in Canada (intercity and rural). These carriers owned and operated some 3,000 buses and 78 trucks of all classes, down from 3,245 the previous year. Employment totalled some 2,700 persons. Property account stood at $25 million; transportation revenue at $48.3 million; and net operating revenue at $1.38 million.

These carriers transported 96,250,000 revenue passengers and 28,000 tons of freight, and operated 108 million vehicle miles during 1954. Gasoline consumption for the year was 15 million gallons and diesel fuel used totalled 3 million gallons. Passengers and freight carried in 1955, as well as the number of vehicles and vehicle miles, was lower than for the previous year. These statistics exclude the buses and passenger revenues, etc., which are part of the urban electric railways.

Intercity and rural bus operators in Canada carried fewer passengers during the first eight months of 1956 than in the same period of 1955, but took in more money than in the 1955 period. Only in Saskatchewan and on interprovincial lines were slight increases in traffic shown. Bus miles operated decreased also but not to the same extent. This was in continuation of the trends experienced in 1955 when 203 carriers showed a 7% drop from 1954 in passengers carried, a slight decrease in miles operated, but a moderate increase in revenue. The decreases in vehicles and passengers was principally due to the growth in the number of automobiles in use.

WATER TRANSPORT

THE CANADIAN water transportation industry included 2,246 vessels of Canadian registry at the end of 1955, according to latest available statistics. This total included 1,738 Canadian owned and operated vessels and 508 chartered vessels, but excluded 89 Canadian ships that did not operate. Several ocean-going vessels in the foreign shipping service of Canadian Pacific Steamship Co., being under British registry, were also excluded. These vessels represented a gross investment of $287 million before depreciation, and the employment in the industry amounted to 21,400 persons.

During 1955, vessels of Canadian registry carried 25.6 million short tons of cargo, or a third of the total loaded and unloaded at Canadian ports in foreign shipping. They also handled 94% of all freight carried in coastwise shipping and all freight on inland lakes and rivers. Operating revenue for that year for freight and other services at $263.3 million was 17.8% over 1954.

Principal cargoes unloaded in 1955, the latest year for which complete figures are available, in order of importance and in millions of tons, were: coal, 13.7; iron ore, 4.7; petroleum and products, 3.9; bauxite, 2.9; crude oil, 2.4; and general cargo, 2.0. Principal cargoes loaded were: grains, 19.1; iron ore, 13.7; gypsum, 3.1; lumber, 2.4; newsprint, 2.2; and pulpwood, 1.8. Following previous trends, the largest part of Canada's waterborne commerce was with United States and the United Kingdom, which combined accounted for three quarters of the total tonnage.

Total cargo loaded and unloaded at all ports for the first nine months of 1956 showed an increase of some 22 per cent over 1955, while coastwise cargo unloaded for the same period increased some 15 per cent. Coastwise service includes vessels of Canadian or British registry only, which arrive at or depart from one Canadian port from or to another, respectively.

Grain, Alumina Raised Pacific Tonnage

Pacific ports had a good year in 1956. More grain passed through than ever before, overtaking loading facilities. Grain shipments are now all in bulk. There was also a sharp increase in tonnage of alumina handled from Jamaica, as Kitimat production built up. Movement of coal to Japan showed an increase over 1955. On the other hand, lumber shipments to foreign countries declined sharply. This was mainly due to the release early last year by Britain of her strategic stockpile of lumber. Much of the B.C. lumber was absorbed by the Canadian housing program.

Grain and Ore Made Up For Decreases

Atlantic ports also enjoyed a record year. Though little lumber was shipped overseas, and the movement of bauxite into Port Alfred dropped due to the longshoremen's strike, grain, coal and iron ore more than made up for the losses. Grain shipments were up sharply from 1955. Iron ore shipments, about 80% of which comes up the St. Lawrence, established a new record. The volume of coal from north central states to Ontario and Quebec ports substantially exceeded the 1955 imports.

Canada's export tonnage always exceeds her import tonnage, due to the fact that the former is mainly made up of heavy bulk shipments of grains, ores, forest products and the like, while the latter is predominantly package goods.

Ocean Rates Rising

Ocean shipping rates are trendin[g] upward. Rates for ocean carriage o[f] all dry cargo move up or down wit[h] the trend of ocean coal rates. I[n] November 1956 it cost some $10 to move a ton of coal across th[e] Atlantic; in January 1957 the rat[e] was around $14. Tanker rates als[o] were trending sharply upward a[t] year-end, mainly due to events a[t] Suez and in the Middle East. Th[e] overseas rate structures on packag[e] goods are set up by the 'Easter[n] Conference' and 'Western Confe[r]ence', both of which have offices i[n] Canada. Changes usually call for 6[0] days' notice.

Tramp business was very acti[ve] last year, exceeding even the lev[el] attained during the Korean war; [a] healthy position from the owne[r's] point of view, though hard on t[he] shipper. Rates charged by tra[mp] vessels are set by their owners [by] the law of supply and demand di[c]tates.

Highlights of 1956 Shipping Season

The 1956 navigation season on t[he] St. Lawrence river and through t[he]

An unusual application of water transport inaugurated in 1956 was the bulk transport of kraft pulp, in "noodle" form, in the specially-constructed tanker S.S. *Duncan Bay* from the Campbell River mill of Crown Zellerbach Canada Limited to the converting plant in California. *(Photo: Jack Cash.)*

TRANSPORT BY WATER AND RAIL

A new record was set in 1956 for iron ore shipments, and a major part in this was played by the Sept Iles, Quebec, terminal of the largest producer, the Iron Ore Company of Canada. The mineral is brought by rail to the terminal, below, and transferred to ore-carriers.

Great Lakes was one of the longest and busiest on record both for freight and passenger service. Ocean navigation opened on 27 March on the river, and on 2 April on the Great Lakes. The Lachine Canal closed on 10 December and the last ocean vessel cleared Montreal on 17 December.

Several hundred vessels docked at Montreal during the year for the first time, and the list included 35 ships from 11 companies on their maiden voyages. Several European shipping lines and a large number of European ships made their initial appearance on Great Lakes runs. Alcoa inaugurated a fortnightly service in November between Canada and Venezuela.

Passenger liners on maiden voyages included the C.P.S. *Empress of Britain*, in April; Cunard's 22,000-ton *Carinthia* and Home Line's 26,000-ton *Homeric* (at Quebec) in June, and Cunard's *Ascania* in November. Freight vessels on maiden voyages to or from Montreal included *Sunoak, Sunmoss,* and *Sunpolyina* for Saguenay Terminals' bauxite runs; *Prinz Willem V,* of Oranje Lines; Furness Withy's *Vanguard* and *Venture;* Montreal Shipping Co.'s *Montclair* and *Capo Faro;* Robert Reford's *Lisa Maersk*; and Swedish American Line's *Voxholm.*

Launchings

Launchings took place in Britain of Cunard's 22,000-ton passenger liner *Sylvania*; and for Canadian Pacific's *Empress of England,* both of which are due on Atlantic runs to Montreal in 1957; the *Sunvictor* which will enter Saguenay Termi-

nal's service in 1957; and in Canada the lakers *Sarniadoc,* and *Metis; Calgaradoc* for Canada Steamship Lines; the *Baffin* for government hydrographic service; and a new icebreaker, the *Montcalm,* which will replace the *Lady Grey.* A 21,000 'laker' of 780,000-bushel capacity, being built at Port Willer for St. Lawrence Transportation Co. will be ready for the 1958 navigation season.

Improvements to Seaway Ports

Though improvements at National Harbours' Board ocean ports in the maritime provinces and in British Columbia were not extensive during 1956, anticipation of the Seaway opening in the spring of 1959 had initiated plans for developing many St. Lawrence and Canadian Great Lakes ports. The N.H.B. expects to spend some $50 million on eight major federal harbours over the next eight years.

Chief beneficiary will be the port of Montreal, where an $11 million program is already well under way. The port of Toronto's Port Authority is keeping well ahead with its traffic handling facilities. At Lakehead, Sarnia, Windsor, Hamilton, Brockville, Cornwall, Trois Rivières, and Quebec, development programs for improvements of harbours and cargo handling facilities of various dimensions and at various costs are planned.

In this respect, development of seaway ports is being paced by the huge sums appropriated for American Great Lakes ports, notably Chicago, Milwaukee, Detroit, Toledo, Cleveland, and Rochester. The United States government is also committed to an expenditure of some $150 million over the next ten years for channel improvements in the five Great Lakes.

Bigger Lake Traffic Means Lower Rates

Few national projects have so captured the imagination of the Canadian people as the St. Lawrence seaway and power project. Several study groups, both in Canada and the United States, are conducting continuous studies of the traffic and economic aspects. Apart from the 2.2 million horsepower to be developed, of which Canada gets one half, the prospects for benefits to navigation and trade are colossal. Tonnage to be carried annually is variously forecast at from 30 to 36 million tons.

Rates on the Great Lakes are generally patterned on the rail rates between the same points. They are influenced by special 'commodity rates' allowed by the railroads over certain periods of the year. Thus they are little affected by changes in ocean rates.

Ungava iron ore production was the leading factor in finally bringing the project to reality in 1954. Economists and engineers foresee inbound traffic due to increase sharply due to this ore movement, resulting in more empty outbound cargo space and thus a trend towards lower shipping rates for Canada's farm and forest products and mineral resources.

Shipping men predict that 'lakers', rather than ocean vessels, will derive the lion's share of the increased traffic. This is due to the extension of a calm protected waterway, wide and deep enough to float these economical, large capacity inland vessels, from its present limits at Prescott right down to the gulf.

Should U.K. Cabotage Treaty Be Repealed ?

But there are many doubts and misgivings among the shipping interests, most prominent among them being the divergent views about legislation respecting coastal shipping. About 8% of this movement is customarily handled by non-Canadian ships, mostly of British registry. Submissions to Canada's Royal Commission on Coastal Shipping, set up in 1954, broadly speaking have criticized Canada's cabotage treaty with the United Kingdom, which permits British flag vessels to carry cargo between Canadian ports and asked its repeal, or argued strongly against any change in legislation.

Owners of Canadian vessels plying the Great Lakes, Canada's shipbuilders, the Dominion Marine Association and some industries are for protection of Canadian vessels by repealing the legislation. The Shipping Federation, the British shipbuilding industry, and grain growers and other groups which want to hold rates down, argued for no change.

They point to the need for Britain to earn dollars to pay for the primary products we sell her. Some urged a wait-and-see policy until it is shown Canadian shipping cannot meet the competition. The railways suggested a compromise by forcing owners of British ships to pay their crews Canadian wages. It appears likely a decision will be deferred as long as possible on this 'hot-potato' issue.

American Subsidies a Threat

Of deep concern to Canadian shipowners was the U.S. Maritime Administration's announcement a year ago that American Great Lakes ship operators would be made eligible for government subsidies by declaring the ocean route between lake ports and Western Europe 'essential' to U.S. trade and economy. Under the new subsidy program U.S. vessels may pick up and discharge at any Canadian lake ports. The program will probably be extended to traffic from lake ports to the Mediterranean, the West Indies, and the Caribbean.

This would create stiff competition for Canadian vessels plying the same route. The Canadian Shipowners' Association contends this means "the seaway will become a beautiful highway for everybody but Canadians, though Canada puts up the money for it".

Tolls Must Be Applied

Seaway tolls present another problem. The Dominion Marine Association, and the Lake Carriers' Association (its American counterpart) have urged that seaway canals should be toll free, saying they had already been tried in Canada and had been abolished. A prompt and firm 'no' was given them by Canadian government officials. It had been a condition of the 1954 agreement between the United States, they pointed out, that tolls should be assessed on shipping sufficient to amortize the cost of building the navigation facilities over a term of fifty years.

Could Seaway be Kept Open In Winter ?

Many ideas have been advanced for keeping the Seaway open in winter by utilizing warmer lake-bottom water, and by diverting its flow through the gulf, but estimated costs outweighed advantages. Interest has arisen, however, in recent proposals to keep seaway channels open by 'bubbler systems', as now used at many Canadian power plants to keep intakes open and to reduce upstream ice pressure on dams, thus permitting more slender designs.

Sweden has been using this idea for years for keeping a ¾-mile ferry channel open, now plans to utilize the principle in maintaining winter navigation on a 60-mile channel connecting the port of Vasteras with the Baltic Sea. For the Seaway, its use would be confined to parts of the 400-mile stretch between Lake Erie and Quebec City, at canal locks and on improved channels, since lake surfaces only freeze over along the shore line and in shallow bays.

Flexible perforated polyethylene pipe of 1½-inch diameter would be used. Total cost of installation is not expected to exceed $2 million. The pipe would be weighted down, and anchored in stretches where the current was swift.

PIPELINE TRANSPORT

At the end of World War II, transportation of oil and natural gas by pipeline in Canada was still in its infancy. Edmonton, Calgary, Lethbridge and surrounding areas received natural gas from the Viking-Kinsella, Bow Island and Turner Valley fields, while in Ontario, Union Gas Co. of Chatham had a pipeline system in Southwestern Ontario. Turner Valley crude was delivered by pipeline to refineries in Calgary, and twin pipelines built during the war brought foreign crude from Portland, Maine, to the Montreal market. Elsewhere movement of crude was entirely by railway tank cars, lake tankers and tank trucks.

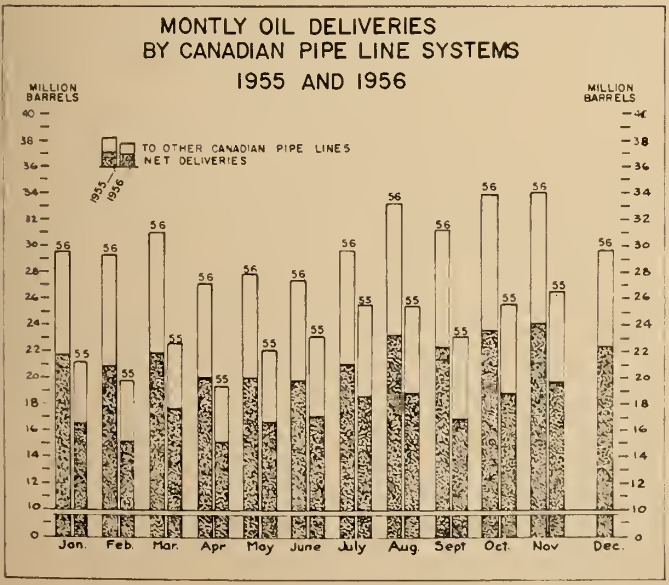
The Boom in Oil Pipelines

Discoveries in the late 'forties' in Alberta made outside markets for Alberta's Leduc and Redwater oil fields an economic necessity, and the 20 inch Interprovincial oil pipeline was built in 1949 from Edmonton to Superior, Wisconsin to fill lake tankers. Later it was extended south of Lake Superior, across the Straits of Mackinac and northern Michigan, right into Sarnia, Ont. By 1952 the 24 inch Transmountain oil pipeline was laid from Edmonton to Vancouver and the B.C.-Washington boundary via the Yellowhead Pass and Kamloops. In 1956 these two main pipelines transported some 97 million and 47 million barrels of oil respectively.

Seven Year Delay For Gas Pipelines

Natural gas pipelines for exporting British Columbia and Alberta gas to distant markets had to wait many years for clarification of policies on the part of the Alberta and Canadian governments, and on U.S. Federal Power Commission approvals. As far back as 1947 many pipeline companies had sought incorporation and competed for the right to serve rich untapped markets in the Pacific Northwest states and in Canada's central provinces.

Finally in October 1955 FPC approval was given for Westcoast Transmission to export gas to the Pacific states. The Trans Canada pipeline system, however, did not get government approval until 1954, when amalgamation between two rival pipeline companies was forced by the Federal government. It could not even then prove its ability to finance the project. Not until June 1956, after long and heated debates in the Canadian House of Commons, did it win promise of government assistance in building its line through the thin market area in Northern Ontario, and approval and loans for building as far as Winnipeg.



1956 Pipeline Building

While pipeline mileage continued to grow during the first half of the fifties, pipeline construction in 1956 topped all previous years by a wide margin. This was of great significance, pointing as it did to a continuing program of this type of hydrocarbon transportation.

Natural gas led the parade of the record pipeline construction season in 1956, with an enormous outbreak of activity from British Columbia to Central Saskatchewan. Westcoast Transmission's 650 mile 30 inch natural gas pipeline, started late in 1955, was 70 per cent completed at year-end and will be in operation by September 1957, connected up at the International Boundary to the Pacific Northwest system, which already is servicing Vancouver with New Mexico gas on a temporary basis. The Saskatchewan Power Corporation laid a record mileage of new trunk lines for its rapidly expanding system. In between, Alberta's domestic markets accounted for even more mileage than Saskatchewan. Finally the long-delayed 34-inch export gas pipeline eastward from Alberta fields made a start on its route to Winnipeg and had 230 miles laid by freezeup, out of its 575 mile distance to Winnipeg.

Though crude oil pipelines assumed a secondary position for construction of new projects and looping of old lines, the economic significance of the year's accomplishments was far greater than the reduced mileage of 1955 would have indicated. New markets were opened up for oil from both Saskatchewan and Alberta by major pipelines, and geographical allocation of fields to markets was readjusted in both provinces.

Products pipelines in eastern Canada expanded their traffic volume much faster than expectations, and plans to loop one products line in

Ontario were completed. Interprovincial announced firm plans to extend 150 miles from the present terminus at Sarnia to Port Credit outside Toronto in 1957, demonstrating Toronto's rising importance as a refining centre.

Total natural gas pipeline mileage for trunk and gathering lines built during 1956 added up to almost 2,200 miles, bringing total gas-line mileage for Canada to close to 5700 miles. City and town distribution system construction across Canada from Vancouver to Toronto added 5 million feet or over nine hundred miles. The total for these distribution lines amounted to over 6700 miles at the end of the year. Total oil pipeline mileage laid in 1956 added up to some 770 miles exclusive of looping, bringing the total oil pipeline mileage in Canada to some 5770 miles. Thus construction of oil, gas, products and gas distribution lines during 1956 totalled some 2970 miles, as shown in detail in Table I.

$118 Million for Purchase of Main Line Pipe

Up to year-end, orders placed for pipe in large sizes for the two major pipeline systems had amounted to some $118 million. Westcoast bought their 30 inch mainline pipe from the South Durham Steel and Iron Works in Britain at a cost of some $32 million. Trans Canada purchased 575 miles of 34 inch pipe for the Alberta-Winnipeg section from U.S. Steel Corporation at a cost of $32 million, and placed a $9 million order with the same company for 24 inch and 12 inch pipe for the Toronto-Ottawa-Montreal section.

In June, Trans Canada announced a contract with the South Durham Steel and Iron Works for supply of 30 inch pipe for the 636 mile northern Ontario section of the line to be built by the Crown Pipeline Corporation from Winnipeg to Kapuskasing. With a pipe mill under construction to produce pipe in large sizes in Canada, a contract for 30 inch pipe from Kapuskasing to Toronto was placed last fall at a price of some $45 million.

Most of the 120,000 tons of pipe needed for the Alberta Gas Trunk Line Company's gathering system, as well as that needed for distribution systems, are of sizes that can be rolled in Canada. Pipe rolling mills have been built at Vancouver, Edmonton, Regina and Sault St. Marie, as well as the big mill of Welland Tube Co., at Welland Ontario, which will commence rolling pipe early in 1957 in sizes up to 34 in. diameter.

Table I. Pipeline Mileage Built In 1956

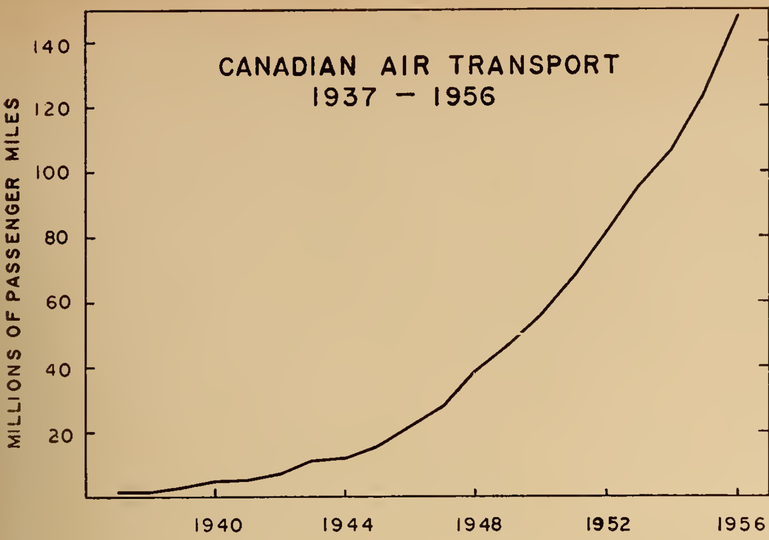
Company	Miles	Size	From	To	Completed
Gas					
Westcoast	460	30"	Taylor, B.C.	U.S. Border	70% Completed
Westcoast	46	20"	Huntington	Vancouver	Completed
Sask. P.C.	120	12"	Success Field	Moose Jaw	Completed
	129	var.	Laterals 10/6/43		
Mid W. Ind. Gas Ltd.	170	10"	Alex Ind. Res.	Wabamun	Completed
S. Alta P.L.	55	10"	Etzikom	Medicine Hat	Completed
B.A. Oil	7	—	Pincher Creek	Sulphur Plant	Completed
C.W.N.G.	109	8"	Extensions		Completed
N.W. Utilities	68	—	Extensions		Completed
Trans Can. P.L.	230	34"	Alta./Sask. Bdry.	Moose Jaw	Completed
Various Cities	800	—	Distribution systems		Completed
1956 Total Gas Lines	**2194**				
Crude Oil					
Imp. Oil	39	12"	Waterdown, Ont.	N. Toronto	(Looping)
Westspur P.L.	159	12") 10") 8")	S.E. Sask. fields	Cromer, Man.	Completed
S. Sask P.L. Co.	67	12"/8"	Dollard	Cantuar	Completed
Interprov. P.L.	69	26"/24"	In Manitoba	Cromer Regina	(Looping)
Cremona P.L.	70	8"	W. Ho/Sundre	Calgary	Completed
Peace Rail P.L.	78	16"/12"/) 8"/4")	Main Gathering Lines		Completed
Texaco Expl.	22		Holmglen-Rimbey	Rangeland	Completed
Britmol P.L.	33	8"	W. Drunhuller Fld.	Old Gulf P.L.	Completed
Pembina P.L.	170	bet.) 16"/4")	Gathering System		Completed
Transprairie P.L.	25	6"			Looping & Gath. Lines
Rangeland P.L.	44	4"	Joffre Field	Bentley Field	Completed
1956 Total Oil Lines	776				

Big Mileage Assured Over Next Two Years

Trans Canada's western section will be completed through Winnipeg to Port Arthur during the current year, as well as the leg between Toronto and Montreal with a branch to Ottawa. The entire gap between Port Arthur and Toronto is scheduled for completion by the late fall of 1958. Construction of the Alberta gathering system will be carried out in three stages over the next three years. Distribution lines including those for the sprawling Inland Natural Gas system throughout interior B.C. and Union Gas Co.'s system in Ontario will also be built. Thus further new records are probably in store for 1957 and 1958.

A products pipeline costing $60 million from Alberta to Lakehead, to be integrated with the Trans Canada system, was proposed during the year by Canadian Hydrocarbons Ltd. Though the exact route was not established, it will include a gathering grid in Alberta with an 8 inch line to Regina and 6 inches eastward.

It will move large quantities of liquid hydrocarbons from the 'wet gas' fields of Alberta which are removed from the gas before it enters the Trans Canada pipeline. Being a common carrier it would also move refined gasoline from Edmonton refineries to Winnipeg. Propane and butane will be carried in liquid state under pressure and sold as heating fuels to distributors along the route. With initial capacity of 10-12 thousand barrels daily, it will have storage facilities along the route. Completion is called for by the end of 1958.



CIVIL AVIATION

The best yardstick with which to measure the growth in Canada's commercial air transport is to compare it with rail transport. Over the past decade, while rail passenger travel decreased 55 per cent, air passenger travel increased by 880 per cent. Air freight during the same period has increased more than threefold.

Though full statistics for 1956 are not yet available, current rates of growth can be measured from the records of Trans Canada Airlines, Canada's 'chosen instrument'. T.C.A.'s passenger traffic for 1956 was 23 per cent higher than in 1955, while air express and air freight recorded gains of 20 and 19 per cent respectively over the previous year. Due to the 'all up' carriage of mail introduced in 1948, air mail ton miles have also grown in an impressive fashion; 1956 witnessed a 12 per cent increase in mail flown compared with the previous year.

Trans Canada Airlines

The traffic increases were made possible by continuance of TCA's program of fleet expansion and modernization. During the year six new aircraft were added to its fleet, which now includes 18 Viscounts, 18 other turboprop aircraft, 9 Superconstellations, 21 North Stars, and 24 DC-3's. The company has almost 8,000 employees distributed over its 2,500 miles of air routes.

At present on order are two Viscounts, as well as four Douglas DC-8 jet aircraft for 1960 delivery, with an option on two more. These DC-8's are powered with Rolls Royce Conway turbojet engines and will carry 120 passengers and three tons of cargo at 550 miles an hour. They will cut present flying time almost in half.

A third of T.C.A.'s service last year was tourist class. Family fares, extended in 1955 to North Atlantic service, were continued. The company also introduced overseas excursion fares and an extra-cities plan for European travellers. Additionally, reduced immigrant fares were started in November. Jointly with other airlines, T.C.A. also cooperated in the carriage of refugees from Hungary and flew large quantities of relief supplies.

Canadian Pacific Airlines

Canadian Pacific Airlines, whose domestic service in Canada is limited to routes of lower traffic density, is developing its services rapidly on transpolar routes to Europe, to the South Pacific, to Mexico and South America, and to Japan. Service was extended last year from Lima, Peru to Buenos Aires, with two flights weekly.

Flights over the North Pole between Vancouver and Amsterdam were increased with a second weekly flight, and a third for the summer traffic peak. In addition, services to Mexico from Toronto were increased from one to three flights weekly, while flights from Vancouver to Honolulu were boosted from two to five flights weekly for the winter tourist season.

During the past year CPA placed orders for 12 more DC6B Empress Airliners. Four of these were delivered in 1956, four will be delivered this year and the remaining four will be in operation by mid-1958. The company also undertook a $20 million expansion program in 1956, which includes a new office building at Vancouver Airport, and a fleet of five long range Bristol Britannia turbo-prop aircraft, the first of which will be delivered in 1957.

To provide a speedy and economical means of international communications to help in developing Canada's world trade, CPA completed a joint project in 1956 with the Canadian National for installation of an international teleprinter exchange service to over 30 foreign countries.

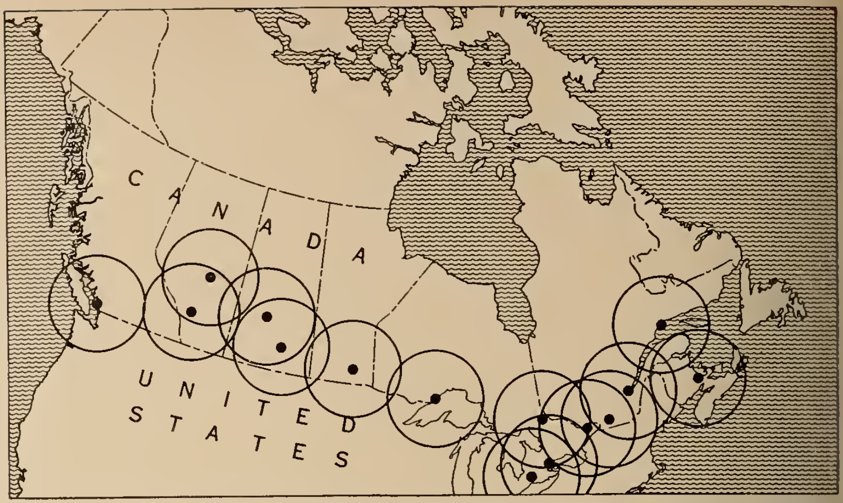
Other Air Carriers

In addition to Trans Canada Airlines, five other scheduled air carriers are operating in Canadian domestic service. These are Canadian Pacific Airlines, Central Northern Airways, Maritime Central Airways, Queen Charlotte Airlines, and Quebecair. These five carriers owned 80 aircraft at the end of 1955 compared with 63 operated on domestic service by T.C.A. at that time. They handled 116 million passenger miles

Steelwork for Montreal's Dorval Airport building. (*Photo: Dominion Bridge Co.*)

in 1955 compared with 668 million for T.C.A., and carried 3 million ton miles of freight compared to T.C.A.'s 13 million ton miles. These scheduled air carriers employed about 2,000 persons.

Beyond these are a group of Class B, C and D non-scheduled air carriers which between them owned or leased 578 aircraft in 1955. Revenue passenger miles for these 'non-scheds' in 1955 amounted to some 9.4 million compared with 826 million for all scheduled domestic air carriers, and 613,000 ton miles of freight haul. The non-scheduled carriers employed some 2150 persons.



Part of the Department of Transport's program of airport development and air traffic control is the installation of radar control, at fifteen of the main airports across the continent, as shown on the map. Network will be almost continuous.

Northern Operations

Northern operations include special airlifts, aerial surveys for industry and for governments, aerial spraying for forest areas, air exploration and geological surveys for the mining and petroleum industries, and other charter flying such as service for the DEW and Mid-Canada radar lines. Looking at civil aviation in these fields, there is little doubt that the future was never brighter.

The wealth of experience gained in the operation of multi-engined aircraft under severe Arctic conditions has been of tremendous value to our civil carriers and to the nation. Air surveying in Canada is experiencing a phenomenal growth and this country now leads the world in the development of airborne geological survey equipment and techniques.

In the helicopter field, the demand in northern areas for this type of service increases each year, and in 1956 more than 60 civil aircraft were registered in this service. Rotary-wing aircraft are playing an increasingly important role in the development of our natural resources. Their use in mainline operating however, is difficult to predict at present.

Ground Facilities and Services

Airports are inadequate in many places and are barely keeping pace with the rapid developments aloft. New runways will have to be built, and at some airports present runways need to be increased in size. At some of the larger airports existing runways will need strengthening to bear the weight of the new and heavier aircraft types. Elsewhere new airports will have to be built in their entirety.

The problem of congestion at airports, while not yet as serious as in the United States, is becoming increasingly acute. Measures must be taken for creation of satellite fields for segregation of military and lighter aircraft in the growing volume of civil aviation operations. New and larger terminal facilities are required at most of Canada's airports, with adequate accommodation for passengers, cargo, and mail, as well as for ground transportation.

There has been rapid development over the past decade in technical aids to navigation over land, sea and in the vicinity of airports. This trend is likely to continue, including provision for better meteorological service, replacement of existing medium-frequency radio ranges, and automatic approach aids. Airborne radar will be further developed for storm surveillance and flight control.

Current additions to airports include a new administration building at Dorval commenced late in 1955, with structural steel now erected, a new terminal building at Ottawa airport costing $2½ million, started in June 1956; new terminal facilities at Torbay Airport in Newfoundland, to be completed in 1957; and a terminal building at Quebec airport costing $750,000 announced August, 1956.

Department of Transport has a sum of $38 million in its 1957/58 estimates, some $17½ million higher than appropriated in 1956. New terminal buildings are proposed at Gander, Dartmouth, Winnipeg, Edmonton, Aklavik, and Yellowknife.

It was announced in April 1956 that Long Range Surveillance radar for control of aircraft on fifteen major Canadian airports would be in operation within two years.

A 40-foot antenna of the type to be installed for the Dept. of Transport was designed to give a scanning range of 200 miles with tracking up to 70,000 feet. ***(Photo: Raytheon Manufacturing Company.)***

Construction and landscape. Above, the Bow River Bridge near Banff, on the Trans Canada Highway. Below, the Highway between Yale and Bell Crossing in the Fraser Canyon, B.C.

CONSTRUCTION

At the close of 1956, having experienced a year in which one in every five dollars spent in end goods and services was a construction dollar, the industry through the Canadian Construction Association, issued a statement of policy.

Its recommendations covered such things as development of increased trade training and immigration programs, conservation of resources, the development of a Dominion-provincial highways board.

Among the conditions accounting for the well being of the construction industry in 1956 were improved economic conditions, increased production of cement, steel, etc., and a larger volume of winter construction.

A point on the C.N.R.'s Beattyville-Chibougamau-St. Felicien branch line in Quebec.

Piledriving for Stelco's new reversing cold mill, November 1956.

THE CONSTRUCTION INDUSTRY is by far the largest in volume of production of all industries in Canada, with an estimated value of work performed totalling about $6 billion in 1956, or 18 per cent of the gross national product.

Some of the main achievements in 1956 were: 136,000 houses and apartment units completed; the St. Lawrence seaway close to the halfway mark in construction, with work well advanced on related hydro-electrical power developments; large power projects such as the Sir Adam Beck and Bersimis hydro projects in operation; the gas pipelines from Alberta to the Pacific Coast and Eastern Canada progressing. Other projects in the news were: the DEW-line and Mid-Canada line of radar installations; pulp and paper mills; oil refineries and petrochemical projects and a number of large scale mining projects; a record roadbuilding program. The huge Camp Gagetown in New Brunswick neared completion, and large projects like the Queen Elizabeth hotel in Montreal, the Imperial Oil building in Toronto and new post offices in Winnipeg and Vancouver were under construction.

The Statistics

The statistical problems relating to the compilation of an up to date report present many difficulties. For this reason a full report is always about a year late in publication.

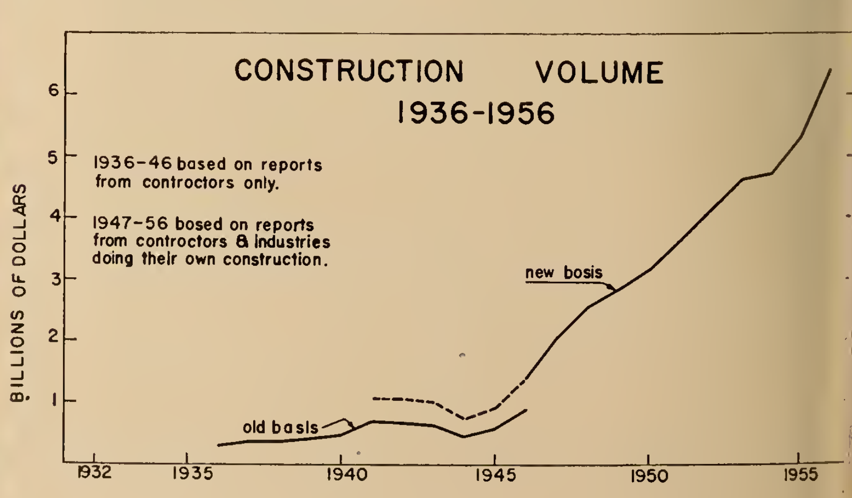
Customarily, however, the full report for any year includes a forecast of intentions for the ensuing year, based mainly on data collected at the same time and from the same sources as that used in the Department of Trade and Commerce Survey of Private and Public Investment in Canada for the year following. Estimates of intended construction in the past have been found to be from 3 to 8 per cent lower than the final estimates after the year was over. In 1955, the estimate of the intended construction program was some 5 per cent lower than the actual total volume put in place during the year. The breakdowns by categories and provinces are of course subject to greater error than the total for Canada.

The value of intended construction for 1956 had been forecast at $6.27 billion, or 19 per cent above the 1955 level, with most of the increase occurring in industrial building and in engineering construction, particularly in gas and oil facilities and in electric power construction, with increases over 1955 of $149 million and $131 million respectively.

Residential building was expected to remain about the same as in 1955. But due in part to the steel strike in the United States last summer, as well as to the tight money situation which developed, and to the sharp drop in residential construction during the last few months of the year, the actual volume may turn out to be nearer to $5.75 billion for 1956, an increase of only about 9 or 10 per cent over 1955.

This is borne out by the report on "Contract Awards" for 1956, published in the Maclean Building Guide, which is based on reports covering about 60 per cent of actual construction done. Awards for residential construction in 1956 were 11½ per cent below those in 1955, though business and industrial category awards were up 9 per cent and 18 per cent respectively, while engineering construction awards showed an increase of 30 per cent over the previous year. Total awards in 1956 showed a 7.6 per cent increase over the total for 1955.

The gain over 1955 in physica



volume was not as great as seemed highly probable even as late as midsummer 1956, and in terms of constant dollars was probably about half cancelled out by the rise in the cost of construction index of about 3.4 per cent during the period.

For the same reasons, the expected average employment in the industry of 648,545 workers as indicated from the survey of "intentions" for 1956, or 100,000 over the average employment in 1955, will probably be an over-estimate. The actual average number of workers in the industry last year will probably be found to be close to 600,000.

Pattern of the Industry, 1955

In the year 1955, the last for which a complete report has been published, the industry employed an average of 550,200 workers, purchased materials valued at $2.46 billion and performed a volume of work valued at $5,285 million. The number of employees working for different groups was divided as follows: contractors, 366,743; utilities, 72,245; governments, 63,862; and others, 47,380.

By regions, British Columbia, employed 54,000 and performed work valued at $572.6 million; the Prairie Provinces employed 109,360 and performed work valued at $1,141 million; Ontario employed 187,870 and performed work valued at $1,841.7 million; Quebec employed 148,670 and performed work valued at $1,343 million; and the four Maritime Provinces employed 50,325 and performed work valued at $387.3 million.

Broken down by categories, values of construction performed in 1955 in millions of dollars for both new construction and repairs, were as follows: residential, $1,734; industrial, $409; commercial, $529.7; institutional, $461.3; other building, 239.8; marine, $77.2; highway and airport, $508; waterworks and sewage, $182.3; dams and irrigation, 29.4; electric power, $328.4; railway and communications, $310.6; gas and oil facilities, $309.6; other engineering construction, $166.3.

Construction Costs

Basic construction costs for residential and non-residential types of construction were on the average 3 per cent higher in 1956 than in the preceding year. This rise compares to a per cent rise from 1954 to 1955. These are C.M.H.C. indices, supplied Canadian Construction Association.

The Home for the Aged and Infirm at St. John's, Nfld. (Top)

The MacMillan and Bloedel building, Pender at Bute Streets, Vancouver. (Right)

The Nickel District Collegiate, Sudbury, Ontario.

Extensions to Saint John General Hospital, Saint John, N.B.

Residential building materials prices averaged 3.3 per cent higher compared to the year before; for non-residential materials the increase was 3.6 per cent. Wage rates rose by 2.9 per cent.

Since the base year of 1949, wage rates of construction workers have advanced considerably more than the other main component of basic construction costs, building materials prices. Basic construction costs in 1956 for residental and non-residential types of construction were 36 and 35 per cent respectively over the levels of 1949. Hourly earnings in these seven years have increased by 50 per cent, while prices of the two major classes of building materials averaged a 30 per cent climb.

New service building at Toronto for T. Eaton Co. Limited. (top of page)

Extension of the Alberta Pool Elevators, Vancouver, adding 2,150,000 bushels capacity. (centre)

New office building for the British Columbia Electric Company, Vancouver. (left)

Credit

There was basis for the opinion that the credit curbs instituted during the year as an anti-inflationary measure seriously affected the industry, especially housing. The restrictions seemed, to some, to be directed mainly against construction. But the higher financing costs on the part of both owner and contractor could have the effect of increasing costs without reducing the number of projects. The industry through C.C.A. asked the government in a brief submitted in February 1957 to consider these effects, as well as the better timing of credit curbs to the seasonal aspect of construction.

There was discussion of methods o cutting costs on new homes to com pensate for the increased interest o mortgages, which was provided t help to make more investment fund available for this purpose.

Efforts were being made to obtai exemption of building materials fro federal tax. Full exemption was re ommended for such things, now onl partially or conditionally exempte as reinforcing or structural stee plumbing, heating, and ventilatin materials; lumber; soil and sewer pipe; and also exemption was requested for a number of electrical materials, nails, septic tanks, air conditioning equipment, some builder's hardware items and construction equipment and tools. The C.C.A. was supported by the Canadian Manufacturers Association and the Canadian Tax Foundation in these requests. It was said such exemptions would remove an appreciable factor in construction costs.

Among other recommendations made toward the financial stability of the industry were requests for certain income tax adjustments, and close supervision of special tariff arrangements concerning temporary importation of construction equipment. Foreign project insurance was recommended. Still outstanding is a decision on C.C.A. recommendations that the use of guarantee or surety bonds be adopted instead of security deposits on federal government projects.

Accounting For The Volume

Manufacturing industries, according to preliminary report of the Department of Trade and Commerce, made capital expenditures of well over one billion dollars in 1956. This included construction at close to $500 million, and machinery and equipment at around $800 million.

Expansion characterized most of the industries, as a later section of this *Journal* will show, taking many forms, and with many projects only partially completed at the end of the year. Some of the larger projects are complex, comprising several phases and costing up to $200 million, and intended to provide power facilities and shops, mills, plants, dock extensions, townsites, etc.

"Warehouse, plant and office" was familiar description of a new project. But published plans contained such various specifications as: smelter wharf and townsite; coal washing plant; power plant; $15 million iron ore development; paperboard mill and office building; cement plants; automotive equipment plant; steel pipe plants; hardwood pulp mills; for the chemical industry, chlorine and caustic soda plant, a pentachlorophenol plant, an ethanolamine plant, polyethylene plant, acrylic fibre producing plant, catalytic reformer; mills in the uranium areas; iron treatment plant; mine buildings; $7 million extension to an already large electrical plant; underground

Federal Building in Lunenberg, N.S., housing postal, fisheries, customs and unemployment offices. Curling Club at Bridgewater, N.S.

reservoir and pumping station.

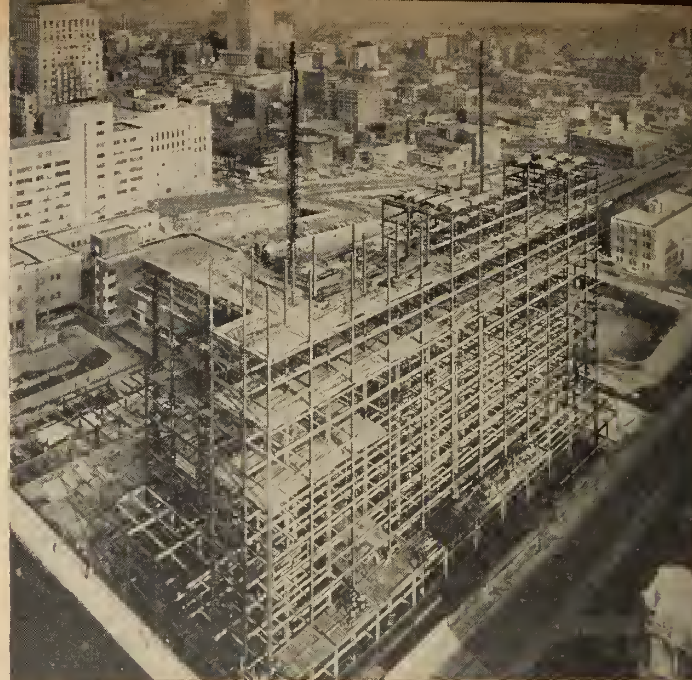
Geographically the expansion was general, moving steadily if not equally in volume, to the east, south and west, but with an increasing pace to the northern development sections.

Many of the large contracts resulted, of course, from the St. Lawrence seaway. The pipelines also represented a large factor in the 1956 volume.

Other components of the capital investment in construction were expenditures by governments on buildings on other structures; by the public utility systems on water works and power projects; by transportation agencies on civil aviation, railway and water transport facilities; by communication companies; by wholesale and retail trade and financial and commercial services on buildings.

Defence Construction awarded contracts to the average value of $10 million a month in 1956—the major projects being accommodation for the Army and communications for the R.C.A.F., the Mid-Canada Line.

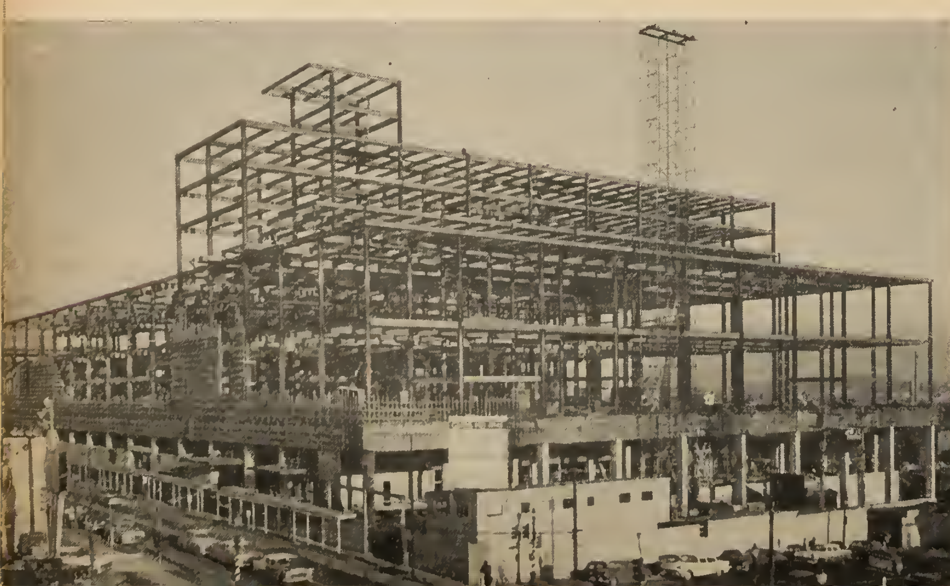
Cement plant at Regina for the Saskatchewan Cement Corporation Ltd.



The C.N.R. Hotel Queen Elizabeth, Montreal, in two phases of construction, during 1956. (above)

The Canadian Broadcasting Corporation Television Studios, Halifax.

The Vancouver post office building will occupy an entire city block. (below)



Housing was a major item, as always, despite adverse financial conditions. The number of houses completed in 1956, 136,000 dwelling units, is a new record in numbers. The actual size and value of these units increased in value also. The number of starts among housing units of modest size fell off sharply in the second half of the year.

The adverse conditions mentioned above are as follows: the untapped sections of the housing market which could affect the volume are mainly in the lower income groups of potential home owners — but a reduction in prices of homes must overcome such factors as rising wage rates, more expensive installations, inflated land costs and often the expense of servicing the land hitherto carried out by the local municipality, higher interest rates and general financing costs, more stringent standards of construction and planning controls.

The C.C.A. has made strong recommendations that the industry and government study the question of the provision of houses to those with annual incomes of $5000 or less.

Institutional Construction

Schools were built in every province to a total estimated cost of $202 million to accommodate the increasing number of students in all levels of education. Enrolment, generally, is higher than ever and promising to be greater still due to postwar birthrates and immigration. On the lists for 1956 were elementary schools, high schools, university additions, convents, kindergartens, school administration buildings, normal schools, vocational schools, many of them large projects.

Hospital construction cost about $130 million in 1956. This phase of construction was also a coast to coast activity. Boards of health and private hospital boards carried out earlier plans or launched programs for needed medical facilities, orphanages, homes for the aged, nurses' residences, etc. Some structures cost up to $15 million.

THE SEAWAY

At the end of the 1956 construction season, with a couple of months more than half the alloted time elapsed, work on the St. Lawrence Seaway and Power Project was 'on schedule', and almost half completed. This was the opinion expressed by officials of the four 'Authorities', one for power and one for navigation in each of the nations concerned.

Some elements were well ahead of schedule. Others were slightly behind, but for these there was still time to catch up. The Long Sault dam, moreover, was being built on a very tight schedule, and continuation of the good progress to date was a 'must' if the first generators can be 'on line' by September 1958. Progress on two of the locks had been slow, but here delays could be overcome by longer or double shifts, or by winter placing of concrete.

Employment Peak in 1957

At the peak of the 1956 construction season in late summer a total of close to 16,000 men were employed 'on site' by all four Authorities. During the winter the force dwindled to around half that figure as dredges closed down and as the placing of concrete on most of the structures on the American side stopped for the winter. Peak employment in the summer of 1957 will exceed that for 1956.

Close co-ordination between all four authorities and the contractors concerned has been imperative. Exact timing for water handling or for changing the course of the river from one channel to another must be carefully followed, due to the interdependence of the various operations and the effect a delay by one may have on others.

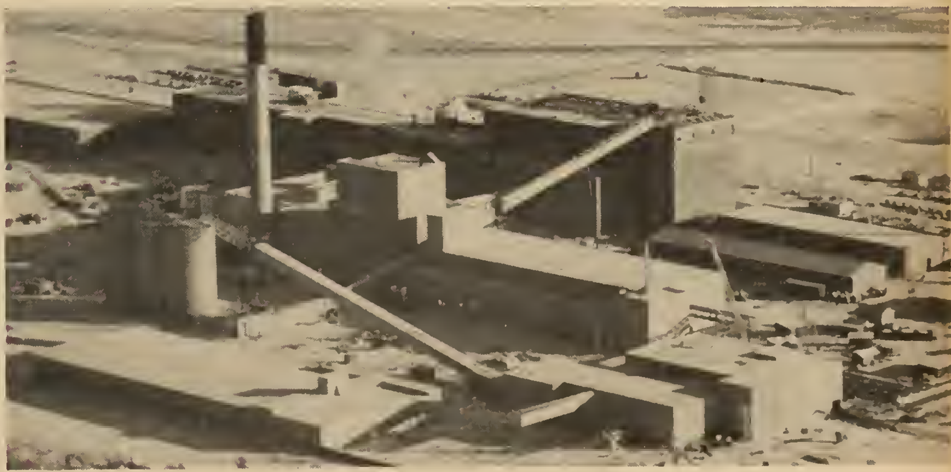
Costs Up

Original estimates for the cost of the project, in round figures, had been set at some $200 million for Canadian navigation channels, five locks and bridge alterations; $105 million for the American navigation channels and two locks. Power facilities were estimated at some $650 million, to be shared equally between the New York Power Authority and the Ontario Hydro. Meantime some additional dredging and two more bridges had been authorized. It was too early to assess what the overall cost would be, but the final bill will likely be considerably higher.

American Channel and Locks

Dredging and excavation of the Long Sault channel across the islands at the upstream end opposite Massena was 95 per cent completed and excavation and dredging along the overland mainland canal was almost half done. Excavation for the two American locks and approaches was two thirds completed. Some 45 per cent of the concrete was placed in the Eisenhower lock, bringing lock walls to two thirds and half height on south and north walls respectively. At the Grasse River lock about a third of the concrete was placed, bringing both lock walls to half height, bringing it to 40 per cent of completion. Placing of concrete on these locks was shut down 1st December.

Three illustrations of industrial expansion, top to bottom: small motors plant for Canadian Westinghouse Limited, at Stratford, Ontario; pulp mill at Hinton, Alta., for North Western Pulp and Power Limited; Dominion Rubber building and warehouse in the Grandview industrial area of Vancouver.



Canadian Navigation Channels

Progress on navigation channels and five locks on the Canadian side by the Canadian Seaway Authority in 1956 was marked by completion of several contracts and a change in emphasis from excavation to the building of structures. All contracts had been awarded excepting for dredging of approach channels to the Iroquois lock and for two dredging contracts for the Welland Canal.

Thirty million yards or 46 per cent of the channel excavation had been done by early November; 250,000 yards of concrete or 15 per cent of the total, had been placed in the lock structures and bridge piers. Only in the summer had placing of concrete been commenced in the first three locks, while on two it was barely started.

Excavation will be substantially completed by the end of 1957, while the next two years will be devoted to finishing the locks, installing gates and equipment, and erecting bridges. About a third of the south lock wall at the St. Lambert lock under Victoria bridge was completed, as well as a substantial portion of the downstream entrance wall. The Côte St. Catherine lock, delayed last winter by high water, was now back on schedule. Concrete for the north wall was almost all poured and a start had been made on the south wall.

The new Children's Memorial Hospital in Montreal, as at January, 1956.

The Lord Simcoe Hotel in Toronto, photographed in November, 1956.

At the upper and lower Beauharnois locks, started early last summer, three contractors were actively excavating the tough sandstone rock at a combined rate of 10,000 yards daily. Excavation for the highway tunnel under the lower lock had been completed and placing concrete for the tunnel started.

For the Iroquois lock, first one to be started, early completion was a necessary factor in the co-ordinated development of the river by Seaway and Power entities. A large and deep excavation across Iroquois Point had to be done first. Concrete placing will continue during the winter.

Three contracts had been awarded for excavation in the dry between locks 1, 2, 3, and 4 of the Welland Ship Canal, to be done during the winter seasons of 1955, 1956 and 1957 while navigation is halted, another for dredging the bottom in the Port Colborne area.

Bridges

There had been little visible sign at year end of bridge construction. However, various steel mills were producing the steel, and fabricating firms were preparing the steel work and completing their plans for erecting the bridges. The south end of Jacques Cartier bridge has to be raised and a new span inserted over the ship channel to provide 120 feet clearance for ships. Lift spans have to be provided on the Victoria rail-highway bridge, lift spans at the C.P.R. Caughnawaga railway bridge, and new high level approaches to the Honore Mercier highway bridge are to be provided. All contracts for these were awarded.

Agreement had been reached for replacing the Roosevelt rail-highway bridge across Cornwall Island, with a high-level highway bridge, with Canada building the piers and United States building the superstructure. Contracts for both had been awarded. A fourth bridge for highway traffic between Montreal and the south shore across Nun's Island was also proposed, and designs and methods of financing and carrying out the work were still under consideration.

Additional Work on Channels

A controversy between the two governments lasting several months had finally been resolved, concerning the dredging of a channel on the north side of Cornwall Island, required for restoring the natural balance of flow under the Boundary Waters Treaty. The Americans had feared this meant early provision of a duplicate channel and locks on the Canadian side. This dredging would be carried out with each Seaway Authority sharing the cost of some $34 million less $12 million from the two power authorities. Canada maintains it is merely a preliminary to possible future duplication.

Above, the Hudson Bay Oil and Gas Co. Ltd. building in Calgary, at this stage in August, 1956.

The Georgian Towers apartment building in Vancouver, containing 160 one- and two-bedroom suites.

ROADS AND BRIDGES

A Year-end summary released by the Canadian Good Roads Association stated that "The year 1956 was the biggest road construction year in Canadian history." A substantial mileage of new modern roads was added to the nation's highway system. A year of peak activity was forecast for 1957.

The most recently published full Dominion Bureau of Statistics report on highways was for the year 1954. This had shown expenditures during that year on highway, bridge and ferry construction of $429 million. Compared with this, all provinces budgeted a total of some $722 million for highway development during the fiscal year of 1956, an all time high. According to the Canadian Good Roads Association, they would actually have spent more than $700 million at the end of that period, 31 March, 1957.

The report on highways for the year 1954 showed a grand total of 524,055 miles of roads in Canada at the end of that year, 192,616 of which were surfaced roads. According to an unofficial Good Roads Association estimate, mileage of all roads today totals some 538,000 miles, 210,000 of which are totally surfaced roads. Probably a little more than half of the two-year growth, or some 8800 miles of all classes of highway were thus added during the year 1956, some 7000 miles of which were surfaced.

Annual "Roads Roundup"

Each year in the months of October or November a "Roads Roundup" is a feature at the Canadian Good Roads Association's annual convention. On this occasion, Provincial Highway Ministers give forecasts of their expected accomplishments to the end of the current year.

British Columbia. At the October, 1956 "Roads Roundup", British Columbia reported a 1956 budget of $80 million, with 149 miles of highway built to date, 62 of which were on the Trans-Canada Highway, bringing the province's total of good highway to 2,498 miles. B.C.'s share of Trans-Canada mileage was 585 miles, reduced by 100 miles from the originally planned project due to a change in location from the "Big Bend" to the Rogers Pass route.

Twenty-one bridges were built at a cost of $3.8 million. Under construction were four major toll bridges, the Agassiz-Rosedale, the Oak Street bridge, and the Second Narrows bridge at Vancouver, and one over the Kootenay river, at Nelson, to be opened in 1957. A four-lane highway tunnel was being built under the Fraser River for completion in 1959.

Alberta appropriated $62 million for 1956 road construction, $7½ million of which was for the Trans-Canada Highway. Greater emphasis was placed on paving, with 267 miles of base course and 308 miles of paving planned; 324 miles of subgrade and grade would be built during the full year and more than 257 miles would be gravel-surfaced, as well as 22 bridges. The Trans-Canada was complete from Calgary to the Saskatchewan border with another 67 miles under construction west of Calgary.

Saskatchewan appropriated $19.7 million and total 1956 expenditure including the Trans-Canada will exceed $26 million. This total excluded expenditures on local roads by grants, etc. Wet weather in June and July had retarded surfacing and equipment was in short supply. Only five miles of surfacing remained at that time on the Trans-Canada, and there was a completely paved route across the province.

Manitoba did not report the province's appropriation for the year, but highway budgets at all levels had been increased over the previous season. The Cabinet had approved a resurfacing program equal to nearly half the total annual vote. The early part of the season had seen most road building equipment and personnel engaged on a system of diking in the Greater Winnipeg area.

The Midtown Bridge in downtown Winnipeg is a four-lane structure with a centre girder span of 170½ feet.

The Agassiz-Rosedale bridge in Vancouver, has a total length including approaches of 6127 ft., with a centre span of 1859 ft.

Ontario's total highway expenditure in 1956 was expected to amount to some $226 million, calling for 800 miles of new paving, 350 miles of resurfacing, 780 miles of grading, and 156 structures. Every effort was being made to complete key sections of the trans-provincial controlled-access Highway 401, 504 miles long. The Queen Elizabeth Way was resurfaced from Burlington to Niagara. The new Burlington Skyway will open early in 1958, while the Allumette bridge near Pembroke was completed. A five-year program for completion of Ontario's 1465 mile share of the Trans-Canada was begun, at an annual outlay of $15 million.

Quebec, with a 1956 roads budget of $100 million, reported that the main highway on the Gaspé Peninsula was near completion and the

Lake St. John and Saguenay highways were completed. The Quebec Murray Bay section of the Quebec Sept-Iles highway was also completed but the balance would take two or more years to complete. By year's-end Quebec's road network of 45,000 miles would have 31,000 miles of improved road, 9000 of it paved with concrete or asphalt. Thus 72% of the network was in good condition.

New Brunswick had allocated some $7 million from capital account for roads and bridges in 1956. An additional $14½ million had been earmarked for roads and bridges, including maintenance and ferries. New paving was under way for 52 miles of highway and 44 miles of recap on existing paved roads. By year's end some 324 miles of surface treatment was expected to be finished, plus some 114 miles of seal coating. About 234 miles of grading and gravelling projects had also been scheduled for 1956.

An extensive bridge-building program included new large bridges at Fredericton, Hartland, Rexton, Andover, Coles Island, Eel River, and Edmundston. Design was completed for two bridges at Oromocto for access to the Gagetown Army Camp.

Nova Scotia expected to spend $13 million on maintenance and $12 million for capital construction, including the Trans-Canada Highway where 30 miles of grading and 18 miles of paving were under way, as well as preparing for another 80 miles of paving. Some 140 miles of paving on other highways was under contract and another 50 miles of paving by the Roads Department.

Prince Edward Island built 10½ miles of subgrade, 7 miles of concrete pavement, and 17½ miles of asphalt pavement for the Trans-Canada Highway, which would complete 90% of the Province's TCH mileage.

Newfoundland's roadbuilding program for 1956 was about the same as for the previous year, with work limited to improvement of drainage and addition of ballast, so that a greater mileage could be reconditioned for traffic during the 1957 Spring breakup. No paving had been scheduled for 1956. The Trans-Canada was open for traffic from Port au Basques to 35 miles east of Gander Airport. Between there and Clarenville a rail-car ferry was operating daily. Contracts for the 16 miles of this gap were let for 1957 construction. It is then proposed to operate a car ferry on the two-mile stretch of water at Clode Sound, making travel possible for the full 600 miles to St. John's.

Report on Trans-Canada Highway

Almost two-thirds of the full length of the Trans-Canada Highway was paved by the end of 1956, according to Federal Public Works Minister Robert Winters; 2735 miles out of the total of 4480 miles were surfaced, with 1536 miles completed to standards of construction agreed upon by Federal and Provincial Governments.

Provinces were preparing realistic schedules to achieve a maximum of reconstruction and new highway by the end of 1960 he stated. There still remained a 164-mile gap on the north shore of Lake Superior, which was not even graded; 100 miles of it was under contract, with the Federal Government paying 90% of the cost versus 50% in the more populated areas.

Vehicle Miles up 6 per cent

According to C. W. Gilchrist, managing director of the Canadian Good Roads Association, Canadians drove their motor vehicles more than ever before during 1956. Preliminary calculations show they drove 37 billion miles during the year, or 6% more than in 1955.

Motor vehicle registrations in 1955 totalled some 3,949,000 an 8.3% in-

Part of Stelco's new pumphouse, under construction at Hamilton, showing one of three pumps, each having capacity of 20,000 Imp. gal. per minute.

Below, an illustration of a new technique. This was the first plastically designed building in Canada, designed by Professors J. W. Brooks and D. T. Wright of Queen's University and recently completed.

crease over the previous year. Passenger car registrations were 9.2% higher and commercial vehicles 6.4% higher than for 1954. There were thus ten motor vehicles registered for every 40 Canadians. This represented an increase of 164% over a ten-year period from 1945.

New passenger car sales at 387,000 units were up almost 25% over the previous year. In addition, foreign tourist vehicles entered Canada in greater numbers during 1956 than ever before, with 8.34 million passenger cars and 387 commercial vehicles crossing the international boundary. Consumption of taxable gasoline, used almost entirely for automotive purposes, rose 10% over 1954.

Preliminary figures by the automobile industry for 1956 indicate a domestic retail sales volume of 405,000 passenger cars and 91,000 commercial vehicles, while the industry expects 1957 volume to reach 425,000 passenger cars and 100,000 commercial vehicles for domestic use.

This poses a most perplexing problem for Canada's road planners, and nowhere is this more evident than in the streets of the large cities. The present balance between miles of modern roads and streets and the requirements of some 4.4 million motor vehicles is tipped so heavily in favour of the vehicle that governments at all levels are finding themselves hard pressed even to maintain the present situation. Continued prosperity may increase vehicle registrations to double the present number over the next 25 years.

TECHNIQUES AND TRENDS

The inroads of new techniques into construction must become more apparent with expansion, as designers adapt new, or conventional, materials to new purposes and locations.

One major construction method more apparent in 1956 than formerly was curtain walling. This is described as cladding of a building in a sheath of glass and panels. It represents a controversial concern of builders, offering for the architect a flexibility of design in a variety of colours and materials. There remains to be settled, it's said, the matter of economy in view of speed of erection, cost of materials, the effect of the design on air conditioning costs. Meanwhile Canadian builders have produced some fine examples of this new style, while many of the major projects also continue to use masonry.

The Canadian Standards Association continued to encourage standardization of building materials. It called attention to the growing interest in dimensional or "modular" co-ordination. It is predicted co-ordinating the dimensions of building elements can effect tremendous savings, without inflicting standardization of design. This would call for co-operation from all quarters supplying building materials. C.S.A. has a committee studying the problem.

The powerhouse of the St. Lawrence seaway project under construction in December 1956. Both American and Canadian sections are shown, with the former in the foreground.

Wintertime construction gained ground in 1956 — reducing the number of employees displaced in the recent season. The major effort of this kind was the Ontario Hydro's work on the St. Lawrence Seaway power-house project. Research is being carried on in techniques and costs, to advance this phase of building, an important one in this country.

A departure in construction was the plan undertaken by Professors D. T. Wright and J. W. Brooks of Queen's University to design, fabricate and construct an office building in Kingston according to their theory of plastic design.

Trends

Some building trends were noted; these were largely influenced by cost, efficiency and use.

It was found that industries tended toward decentralization to take advantage of favourable land costs in suburban and small city locations. Leasehold arrangements of major proportions were carried out or announced in 1956.

Shopping centres, and apartment developments were continuing and typical factors. House builders were using new methods of production, new materials, public relations and merchandising, to attract new buyers. It became practical in 1956 to move towns, house by house, as the Ontario Hydro demonstrated at Iroquois and Morrisburg, Ontario.

PHOTOGRAPHS

Acknowledgment is given to the following contributors of pictures for this Construction Section:

Poole Construction Company Limited, Pages 601-1, 605-3, 607-2, 609-1; Department of Highways of B.C., 601-2, 610-2; The Steel Company of Canada, Limited, 602-2, 611-1; Dominion Construction Company Limited, 603-2, 604-2, 607-3; Foundation Company of Canada Limited, 603-3, 606-3, 607-1, Alward & Gillies, Mott & Myles, 603-4; Canadian National Railways 602-1, 606-1; J.L.E. Price & Company Limited, 603-1, 608-1; Redfern Construction Company Limited, 604-1; Dominion Bridge Company Limited, 604-3, 606-2, 606-4, 610-1.

Acadia Construction Limited, Page 605-1, 2, Angus Robertson Limited, 608-2; Georgian Towers Ltd., 609-2; D. T. Wright Queen's University, 611-2; Uhl, Hall and Rich, 612-1.

Symbolizing the industries on which much of Canada's secondary production is based are these views of coke being discharged into a quenching car and of a 1000-ton blast furnace. (Photos: Dominion Steel and Coal Corporation, and Toronto Iron Works, Limited).

INDUSTRIAL PRODUCTION

IRON AND STEEL
NON-FERROUS METALS
MACHINERY AND TOOLS
FARM IMPLEMENTS
ELECTRICAL MANUFACTURE
SHIPBUILDING
RAILWAY EQUIPMENT
MOTOR VEHICLES
AIRCRAFT
ASBESTOS PRODUCTS
CEMENT AND CONCRETE
CLAY PRODUCTS
LEATHER
LUMBER
RUBBER
CHEMICAL INDUSTRY

IRON AND STEEL

THE PRIMARY iron and steel industry set a new record in 1956 with ingot production of 5,179,347 net tons, 16.6% higher than the 4,441,743 net tons produced in 1955. Last year's ingot production was 62% higher than in 1954, and more than double the production a decade ago. The industry operated at 99.76 of its rated ingot capacity. In the final quarter of the year it reached its best pace at 100.2% of capacity.

In recent years Canadian ingot capacity has expanded more rapidly than the steel industry of any other major nation. Ingot capacity for all Canada is now rated at 5,504,000 net tons yearly, a 6% increase over the capacity at the end of 1955. Of this total 754,000 tons or some 12% represents electric furnace capacity. Canada is thus capable of producing some 72% of the nation's primary steel requirements.

Sixteen blast furnaces in Canada are now rated at a combined capacity of 3,900,000 net tons of pig iron. Production for 1956 at 3,368,359 net tons was almost 5% higher than the 3,213,764 tons produced the previous year.

Pattern of the Industry in 1954

The annual statistical report for the industry for 1954, the last complete one available, covered operations of 49 firms and included reports from 63 plants or departments with 5 blast furnaces, 4 ferro-alloy plants, 39 steel furnace divisions and 15 rolling or drawing mills. These firms had a total employment of 28,861 persons, 17.4% lower than for the previous year, 70% of whom were employed in Ontario. Materials used were valued at $145 million.

Charges to iron blast furnaces included 2.96 million tons of imported ore, 0.79 million tons of Canadian ore, 1.97 million tons of coke, and 0.78 million tons of limestone. Imports of pig totalled 20,000 tons, and exports 202,000 tons. At year-end producers' stocks of pig stood at 128,000 tons.

Output of pig iron at 2,211,029 net tons in 1954 was 26% lower than in 1953. Production of basic iron was 1,740,710 tons or 78.7% of the total. Foundry iron amounted to 167,797 tons and malleable iron to 302,520 tons. Producers' sales of pig iron totalled 455,552 tons. Actual production at 2.2 million net tons showed an operating rate of 57%.

Steel Ingots and Castings

Thirty-nine steel plants in operation in 1954 had 128 furnaces including 42 basic open-hearth and 82 electric furnaces, two converters, two oxygen converters, and two Bessemer converters. These furnaces used 1,767,300 tons of pig iron, 1,629,866 tons of scrap, 203,120 tons of iron ore, 182,970 tons of limestone, 136,000 tons of dolomite, 81,440 tons of lime, 74,000 tons of sand, 9,900 ton of magnesite, and 41,530 tons of ferro-alloys. 1954 steel production at 3.2 million tons was 22.4% below 1953, with most of the decline occurring in ingots. Factory sales totalled 86.066 tons valued at $35.4 million.

Rolled and Drawn Steel

Of twelve mills operating in 1954 for hot-rolling of steel products and three mills making only cold-drawn and cold rolled shapes, nine were in Ontario, two in Nova Scotia, two in Quebec, one in Manitoba, and one in British Columbia. Rolling mill sales for 1954 at $301,926,000 were down 12.6% below 1953. Main items sold were 445,519 tons of hot rolled bars, 201,524 tons of plate, 283,297 tons of rails and fastenings, 150,917 tons of blooms and billets, 180,144 tons of structurals, 274,870 tons of wire rods, 28,829 tons of cold reduced bars, and 900,484 tons of other rolled products.

Ferro-Alloys

Ferro-alloys were produced in 1954 by ten establishments, five of which received ferro-silicon as a by-product from abrasive producers. Output amounted to 116,141 tons, a decline of some 24½% from 1953 production.

Consumption by Industries in 1954

The total tonnage of iron, iron castings, and products made in iron and steel rolling and drawing mills in 1954 and shipped to various industries, amounting to some 3.79 million tons, was divided as follows in millions of tons: construction 0.372; merchant trade products 0.348; wholesalers and warehouses 0.330; railway operation, 0.307; containers, 0.272; pressing, forming and stamping, 0.161; machinery and tools 0.152; automotive industries, 0.140 mining and lumbering, 0.137; railway rolling stock, 0.121; farm implements 0.074; national defence, 0.037 shipbuilding, 0.015; miscellaneous

In this general view of the Dominion Foundries and Steel Company's plant at Hamilton, Ont., may be seen the oxygen steel-making plant (prominent light building, right centre). Coal handling plant and coke ovens are immediately behind the stack, and the blast furnace is at the top left.

0.013; producers interchange and exports, 1.32.

Imports and Exports

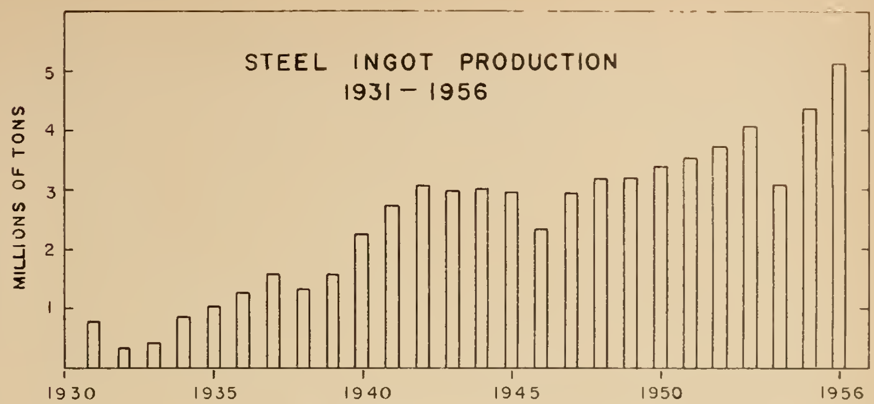
Imports of primary forms of iron and steel in 1954 included 1,095,-858 tons of carbon steel, 78% of it from United States; 33,566 tons of alloy steel, 94% of it from United States and 8,151 tons of stainless steel, 75% of it from the United States.

Exports the same year totalled 260,868 tons, 78% of it in the form of pig iron, 11% in the form of plates, sheets and strips, 5% in the form of iron and steel castings, 4% in the form of ingots, blooms, billets and bars.

Industry Leaders in 1956

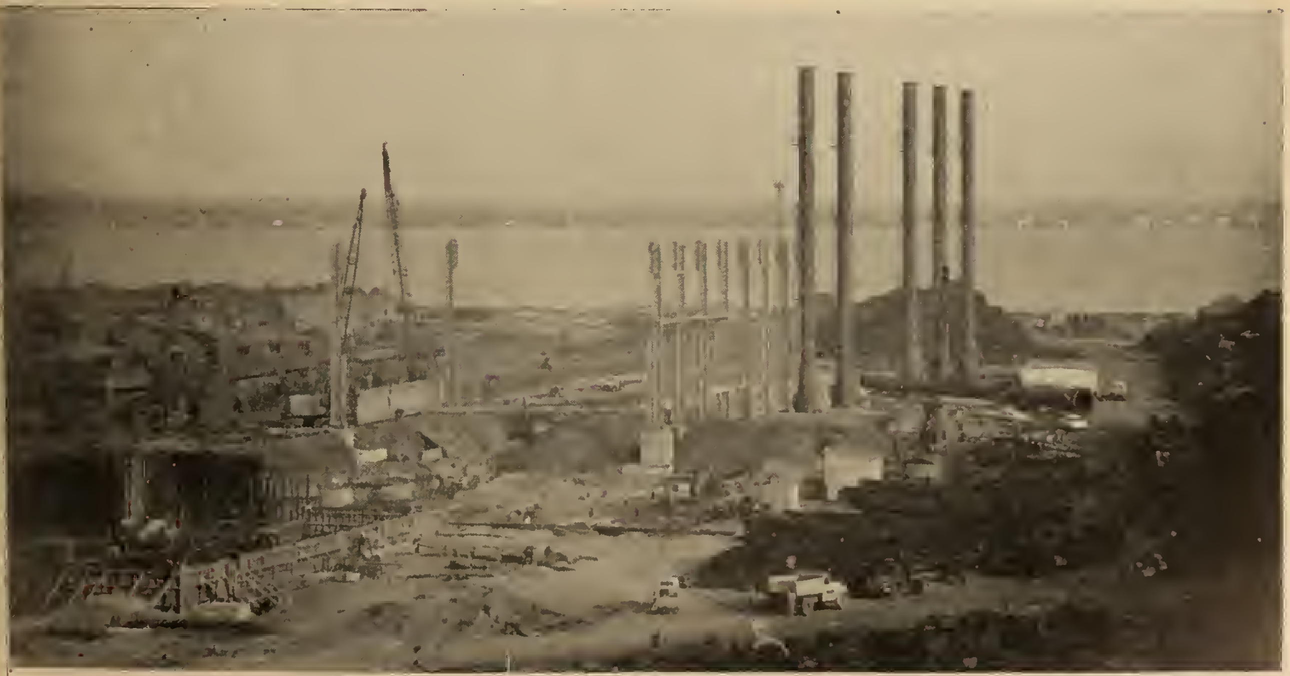
"Stelco", or the Steel Company of Canada, Canada's leading steel producer, produced 2,367,134 tons of ingot in 1956, up 15% from the previous year, and increased sales to $272.9 million, up 20% from 1955. The company has invested $185 million in expansion since 1945. At the end of 1955 it authorized an expansion program for its Hamilton works costing $70 million, including a new blooming mill, scheduled for completion by the end of 1958. Last year it joined with Page Hersey Tubes Ltd. in forming a new company, Welland Tubes Ltd., to build a $10 million pipe mill for initial 1957 production of steel pipe in sizes up to 34 inches diameter.

The Algoma Steel Corporation at



Steel ingots are heated in soaking pits before further processing. *(Dosco photo.)*

Below is a general view of construction work at the No. 2 blooming mill site of The Steel Company of Canada Limited plant at Hamilton. In the far right background may be seen the piers of the Burlington Skyway.



Sault Ste. Marie increased its ingot production to 1,104,750 tons of ingot in 1956, 11½% more than in the previous year. Shipments of iron ore and steel were also up at 1,476,613 tons; new records in both cases. The company is undertaking a $67 million program this year to expand ingot capacity by half a million tons, with the objective of a 25% sales increase by 1959. Capacity production is anticipated during the first half of 1957.

In 1956 the company spent $8 million in expansion, double the amount spent in 1955, to bring capacity up to the present 1,280,000 tons. The new Mannesmann tube mill at the 'Soo', with which it is affiliated, will provide Algoma with a further outlet for some 225,000 tons of plate for seamless pipe.

Dominion Steel and Coal Corporation, Ltd., (Dosco) apparently increased ingot production in 1956 to some 653,000 tons, up 25% from 1955. The company's ingot capacity from three blast furnaces at the end of 1956 was 720,000 tons. A subsidiary, Canadian Tube and Steel Products Ltd., at Montreal, produces a further 100,000 tons. After completion next July of Dosco's new 225,000 ton open hearth furnace, capacity will be increased to 950,000 tons.

Dominion Foundries and Steel Co., Ltd., at Hamilton had eleven furnaces in operation last year, five of them electric and two of them oxygen vessels, with a combined capacity of 785,000 tons. Last year the company spent $26.6 million to install a third oxygen steel furnace and a second blast furnace. Production has been doubled in recent years. Plans for 1957 include a new hot-roughing mill.

Atlas Steels Ltd., of Welland, Ont., produces ferro-alloys and specialty and stainless steels. Its six electric furnaces have a combined capacity of 169,600 tons. A $12 million five-year expansion program at present under way will add 17,000 tons per month to capacity. Recently it has started continuous casting and has added a hot planetary mill, both well in advance of U.S. practice. It has also been first to introduce the oxygen-steel converter to Canadian practice.

The runner hub assembly of one of the turbines for the Niagara pumped storage scheme. Six such units will pump off-load water into a reservoir; by reversal of the units power can be generated. (*Photo: English Electric Company of Canada.*)

Industry Measures to Meet Foreign Competition

Canada's steel industry, with ingot capacity only some 2% of world capacity, is extremely sensitive to world influences and to competitive conditions. It must compete cost-wise with producers in the United States whose output is 25 times larger than our own. Technical advances have allowed us to narrow the gap between our mill prices and theirs. But our steel prices must also be competitive with those of the mills in Western Europe with a combined ingot capacity 16 times as large as Canada's and with wage scales only about a third of those paid to Canadian workers.

The Canadian iron and steel industry is following its own line of steel development. Evolution is proceeding in three phases,—first, through attempts to boost production from existing equipment; second through introduction of new low-cost methods to compete with established companies; and third, through new processes suitable to Canada for processing ore to steel for export.

Canada will soon become the free world's third biggest producer of iron. Production has already passed that of Britain and of Germany and will soon exceed that of France and Sweden. Today's 15 blast furnaces produce some 3½ million tons of pig iron. By 1980, industry leaders see Canada needing almost double this production, which would mean addition of seven big new blast furnaces. However, by using beneficiated ores (iron pellets or sinter) the number needed might be reduced to two new furnaces, at a saving of an investment of some $90 million to $100 million.

SECONDARY STEEL

To ROUND OUT the record of Canadian steel production, statistics of three other secondary industries not included elsewhere in this issue should be added. Complete records of production of these industries are not available for 1955 and 1956, but their relative importance can be measured from DBS reports for 195[illegible] the most recent year for which complete reports are available.

Sheet Metal Products

Factory shipments of sheet metal products in 1956 were valued

$278.6 million, 8 per cent higher than in 1955 and 19 per cent higher than in 1954.

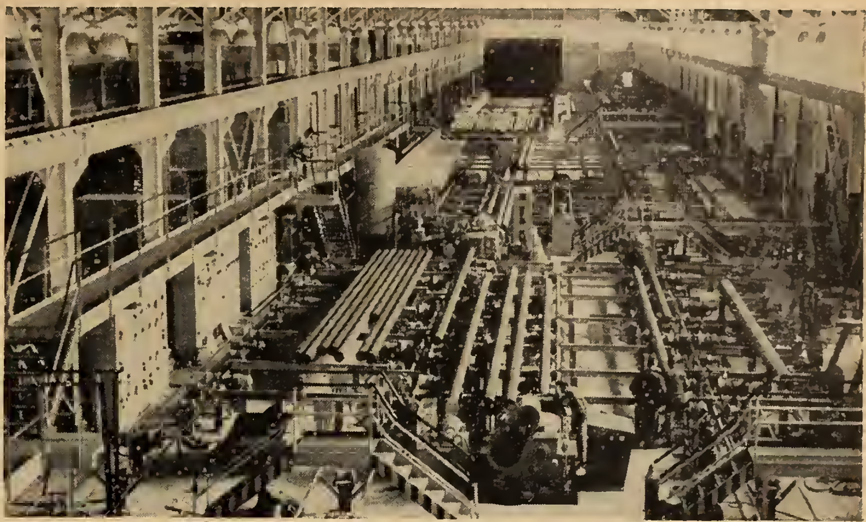
There were 343 establishments in 1954 engaged in the manufacture of articles from steel sheets, tinplate, and galvanized plate, whose main products were tin cans, galvanized sheets, bottle caps, building material, kitchenware, culverts, barrels and drums, and eavestrough. These plants together employed some 18,000 persons: 10,554 of whom were in Ontario; 4140 in Quebec; 961 in British Columbia; 875 in Manitoba; 384 in Alberta; 228 in Saskatchewan and 107 in the Maritimes.

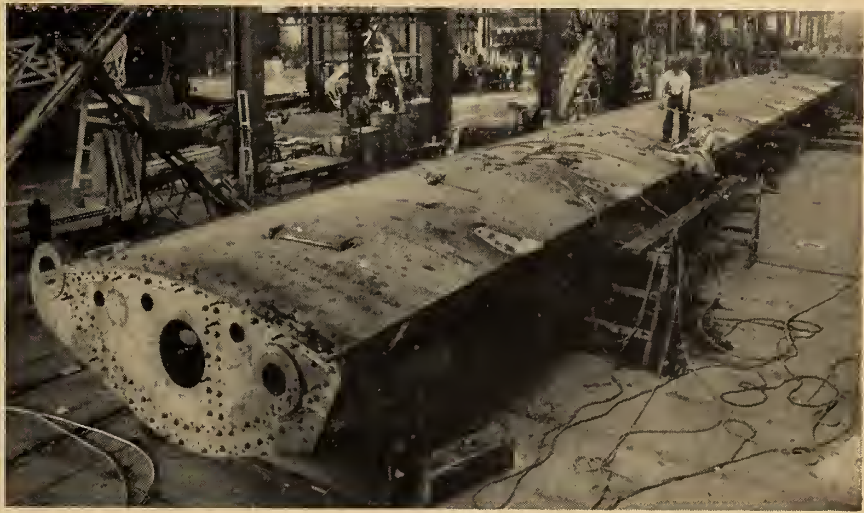
Materials purchased were valued at $118.8 million. Value added by manufacture amounted to $112.2 million, and gross selling value totalled $232.7 million. Values of the main items produced were as follows; cans, $77.8 million; steel and aluminum windows, $15 million; bottle caps $10.5 million; culvert pipe $10.8 million; roofing and siding, $6.8 million; hotel kitchen equipment, $4.4 million; motor vehicle bodies, $3.8 million; barrels and drums $2.3 million; metal lath $3.4 million; and other products $9.5 million.

Miscellaneous Iron and Steel Production

Shipments of miscellaneous iron and steel products in 1955 were valued at $119.5 million, 5 per cent lower than for the previous year.

There were 320 establishments in the miscellaneous iron and steel industry, in 1954, which between them employed 12,150 persons; 6573 of whom were in Ontario, 3635 in Quebec, 898 in the maritimes, 595 in Manitoba, 420 in Alberta and British Columbia. Materials purchased were valued at $46.3 million, and included 11,853 tons of pig iron, 140,000 tons of steel in various forms and





Development of the Canadian oil and gas industries has led to increased demand for steel pipe. Top picture shows the finishing bay of the Alberta Phoenix Tube & Pipe Limited plant at Edmonton, established in 1956.

Centre: One of 13 submersible gates, each 100 ft. long by 10.5 ft. high, for Ontario Hydro's Grass Island weir at Niagara Falls, Ont. *(Photo: Canadian Vickers Limited.)*

A hydraulic head gate for the Ontario Hydro section of the International powerhouse at Cornwall, Ont. (one of 48). *(Photo: Dominion Bridge Company.)*

9300 tons of scrap. Value added by manufacture amounted to $75.9 million, and gross selling value to $126.1 million. Products included ornamental and structural ironwork, steel forgings, safes and vaults, railway track equipment, mining machinery, fireplace furnishings, and steel wool.

Gross selling value of the principal products were as follows: forgings $16.6 million; sanitary ware $14 million; iron and steel architectural work $15.2 million; aluminum architectural work $1.1 million; railway track equipment, $2.7 million; safes and vaults $2 million; and machinery $1.95 million.

Bridge Building and Structural Steel Production

Value of factory shipments of bridge building and structural steel in 1956 amounted to $199.5 million, 27 per cent higher than the value of shipments in 1954.

There were 43 establishments in 1954 in this industry, which includes all those chiefly occupied in fabricating or erecting steel for bridges, buildings, etc. Total employment amounted to 10,881 persons, most of whom are included with employment shown in the construction industry. Twelve of the plants were in Quebec, 21 in Ontario, four in British Columbia, three in Alberta, two in Manitoba and one in Nova Scotia.

Value of the principal products was as follows: 276,590 tons of structural steel for buildings, valued at $82 million; 66,067 tons of structural steel for bridges, towers, etc., $24.2 million; plate and tank work, $12.9 million; mechanical work such as cranes, trolleys, and machinery, $9.5 million; and sales of plain materials, $13.74 million.

Apart from the millions of tons of iron and steel shipped last year to warehouses, the mercantile trade and various industries in the form of castings, ingots, plate rails, bars, blooms, billets and slabs, a partial list of some of the structural steel end-products supplied or currently being fabricated for the construction industry are of special interest.

Some 22,000 tons of structural steel for eight large bridges at Vancouver, Winnipeg, Montreal, Lachine and Toronto.

Some 25,000 tons of structural steel for two hotels at Toronto and Montreal, a post office at Vancouver and two office buildings at Montreal.

Some 26,000 tons for 48 headgates, 32 control gates and a gantry crane for the St. Lawrence seaway development as well as several submersible lock gates and drum gates.

About 15,000 tons for Ontario uranium developments; 2,000 tons for an Alberta pulp mill; 2,000 tons for 40 microwave towers in Western Canada; and gates for a large irrigation dam in South America.

IRON CASTINGS

Canada's iron foundry industry established new records in 1956, with over a million tons of castings, pipe, and fittings being produced during the year. Some 700,000 tons of this was in the form of grey iron general castings. *Per capita* consumption of Canadian castings has risen during the past decade from 61 to 89 pounds.

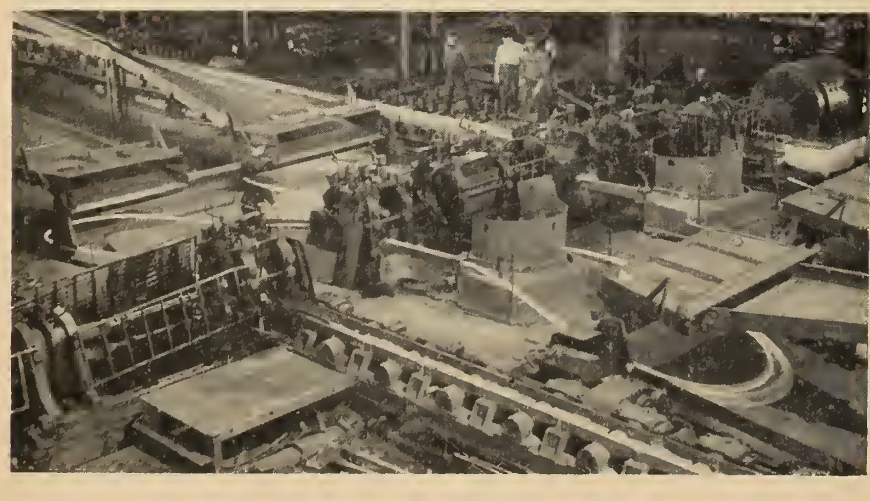
Total tonnage made in 1956 included 72,081 tons of cast iron castings, cast iron pipe and fittings, soil and water pipe, and 30,200 tons of steel pipe tubing and fittings. Tonnage shipped for use in Canada or for export during the year, excluding quantities used to make other products such as stoves, machinery, etc., totalled 1,182,000 tons, compared with 992,660 tons in 1955; an increase of 19 per cent. Consumption of pig iron at 356,700 tons and of scrap at 796,600 tons was higher than in 1955 by some 8 per cent.

The industry covers operations of iron and steel works occupied chiefly in making commercial iron castings or iron and steel pipe and tubing. Some machinery, boilers, engines, stoves and furnaces, etc. were made as secondary or minor products. Some makers of agricultural implements and stove manufacturers who have their own foundries are included elsewhere with the Farm Implements and with Heating and Cooking Apparatus industries, respectively.

In 1954, the last year for which complete industry statistics are available, based on 202 establishments reporting, 75 per cent of them in Ontario and Quebec, the industry employed 13,784 persons, purchased materials valued at $61 66 million, added a value of $76.67 million by manufacture, and shipped products valued at $139.9 million during the year. This value of shipments was 11 per cent lower than in 1953. Employment in the industry totalled over 23,000 in 1929, dropping to 9,635 in 1939 and recovered to 18,340 in 1949, since which year it had dropped steadily to 13,748 in 1954.

A special study of all reports submitted to D.B.S. has indicated a total of some 400 operating foundries distributed across Canada in 1954, which together used 267,000 tons of pig iron, 529,000 tons of scrap, and 147 tons of cupola coke. Their production totalled 713,000 tons of iron castings.

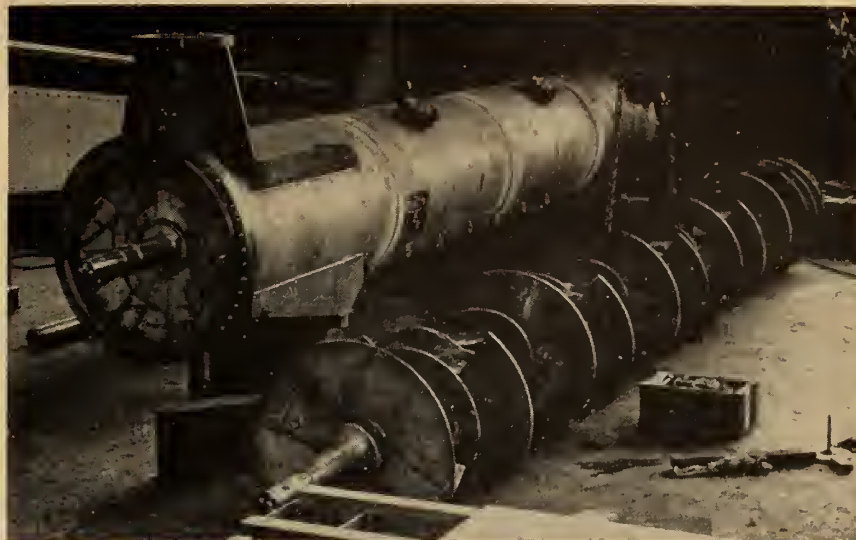
Consumption of the principal materials used by the industry in 1954 were valued, in millions of dollars, as follows: skelp, 23; pig iron, 8.8; scrap iron and steel of all kinds, 8.8; hot or cold rolled steel, 2.42; coke,



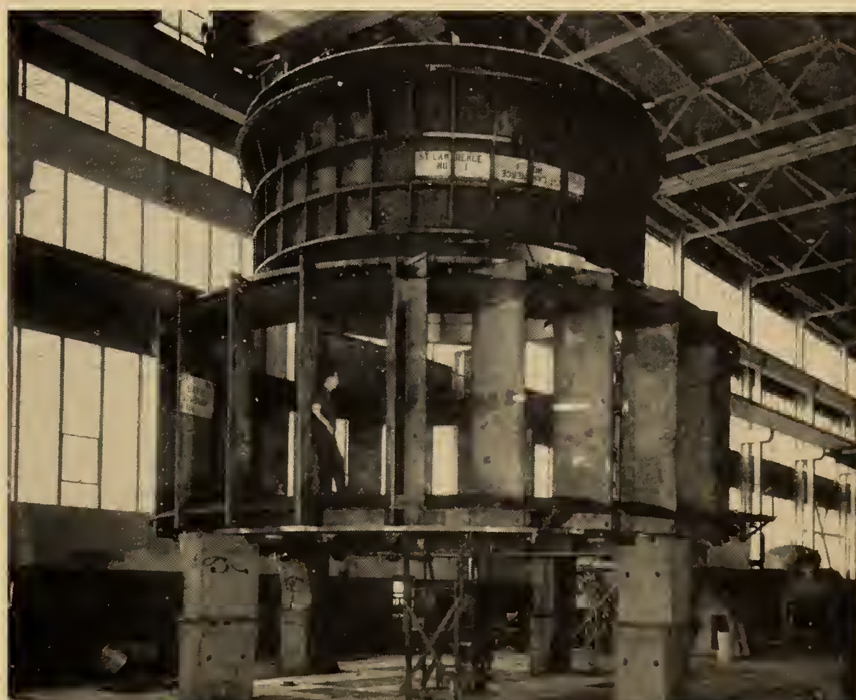
STEEL PROCESSING

Further steel processing operation is the passing of steel billets through a series of reducing rolls to make smaller-sized rod and bar. *(Photo: Dominion Steel and Coal Corporation.)*

New to Canada in 1956 was this screw-type digester for the pulp and paper industry. *(Photo: Dominion Bridge.)*



The manufacture of heavy equipment for the hydro-electric power industry is a major activity on the Canadian industrial scene. The picture below shows a discharge ring being lowered through the speed ring for a matching and blending operation. *(Photo: English Electric Company of Canada.)*



2.0; iron and steel pipe, 1.7; brass and bronze, 1.6; other iron and steel, 1.26; zinc 0.86; ferro-alloys, 0.86; aluminum, 0.21; nickel 0.26; sand, 0.28; firebrick, 0.24; lumber, 0.20; core oil, 0.16; paints, 0.19; containers, 0.36; and other materials, 8.51.

The industry continues to make progress towards better technology. The CO_2 process of mould making and core-making is finding useful applications. A new modification of standard core-oil formulas which decreases baking time is proving valuable particularly for cost reduction in heavy work.

Canada's first hot-blast unit on a foundry cupola, aimed at decreasing costs and at better metal quality was put into operation in Toronto in 1956. Improved foundry practice and metallurgical techniques have contributed to enhanced quality and range of metal properties available in iron castings.

BOILER AND PLATE

THE BOILER and plate work industry includes the operation of establishments that make as their chief products such articles as heating and power boilers, heating radiators, tanks and miscellaneous products from steel plate such as bins, hoppers, smokestacks, etc.

Shipments of boilers, radiators and other products of the industry during 1956, according to preliminary reports of the Dominion Bureau of Statistics, amounted to a value of some $124.6 million, 42 per cent higher than in 1954.

In 1954, the latest year for which full statistics have been published, there were 89 such establishments in Canada, which employed 8,127 persons, purchased materials valued at $35.9 million, added a value of $50.44 million by manufacture and produced goods valued at $87.6 million. This compared with production valued at $96.6 million the previous year and production valued at $90.4 million in 1952.

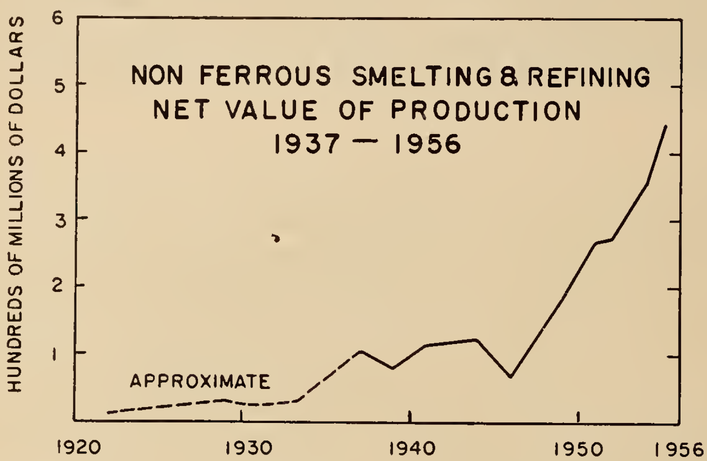
Forty-eight firms in Ontario account for nearly three quarters of the total employment in the industry, while 17 firms in Quebec account for a fifth of employment. British Columbia with 11 firms comes next, with the three prairie provinces employing 340 persons between them.

A list of the principal materials used in manufacture in 1954 included some 137,000 tons of steel, 20,000 tons of pig iron, 16,000 tons of scrap, 41 tons of aluminum, 15 tons of copper, 4½ tons of nickel, 25 tons of lead, 5 tons of babbitt, 8,000 tons of coke, 9,000 tons of sand, 9,000 barrels of oil.

During 1954 some 19,000 heating boilers of various sizes and some 330 power boilers were shipped, combined value of which was $16.35 million. Total production of heating radiators totalling 14.7 million square feet were produced, having a value of $9.2 million. Capital and repair expenditures for the industry in the same year totalled $4.7 million.

NON-FERROUS METALS

The smelting and refining industry includes only those firms engaged primarily in smelting of non-ferrous ores or concentrates and in the refining of metals recovered therefrom. The smelting of imported ores is included, but secondary smelters, which treat scrap metals only, are not. The list of metals covered includes copper, nickel, lead, zinc, aluminum, magnesium, titanium, molybdenite, tungsten, cobalt, antimony, bismuth, cadmium, selenium, tellurium and precious metals. Refining of crude oil is not included.



Full statistics for 1956 are not available for smelting and refining of metals but the value of shipments by the industry in that year reached a total of some $1,239,000,000, up 2¼ per cent from the previous year.

In 1955, the last year for which a complete report was published, 24 establishments employing 28,600 persons showed a combined gross value of products shipped during that year, including containers, of $1,211,716,-481. They spent $118,189,000 in wages, purchased supplies valued at $60,874,000, purchased fuel and power valued at $56,949,000, and added a net value of production amounting to $444 million.

The gross value of products shipped in 1955 was more than double the value in 1949 and up almost fourfold from production shipped two decades ago. Capital and repair expenditures for five years ending in December 1955 totalled $481 million. Smelting capacities for the principal metals at the end of 1955 in tons per year stood as follows: smelting of copper ore and concentrates 5,455,000; copper refining, 350,000; lead smelting 711,000; electrolytic zinc, 273,000.

In 1955, production was: 289,000 tons of refined copper, 174,928 tons of nickel, 148,811 tons of refined lead, 256,542 tons of refined zinc, 960 tons of cadmium, 133 tons of bismuth, 612,543 tons of aluminum, 246 tons of tin and antimony, 971 tons of refined tungsten and molybdenite, 786 tons of cobalt, 117,042 tons of titanium dioxide slag, 213 tons of selenium, and 4½ tons of tellurium. Production of new gold and silver were valued at $156.8 million and $24.7 million, respectively.

ALUMINUM

Canada's production of aluminum ingots during 1956 reached a record total of 614,721 tons, compared with 612,543 tons the previous year, and more than three times the annual production ten years ago.

Although there is no bauxite mined in Canada, the aluminum smelting industry is exceeded in size only by that of the United States. The principal factor favouring establishment of the industry in Canada is abundant and low-cost hydro power at points where necessary raw materials can be cheaply and conveniently assembled.

The principal imported raw materials used in the industry are bauxite from British Guiana, alumina from Jamaica, coal and coke from the United States, fluorspar from Newfoundland, and cryolite from Greenland and the United States. The Aluminum Company of Canada, Limited, operates its alumina plant at Arvida and its reduction plants at Arvida, Isle Maligne, Shawinigan Falls, and Beauharnois. The Company's new plant at Kitimat, B.C., which began production in 1954, is being expanded. Electric power for this plant is generated at Kemano, while alumina for the smelter is brought by ship from Jamaica.

For the year 1955, the last year for which full statistics are currently available, producers' shipments of aluminum ingots amounted to 612,-543 tons. Canadian comsumption amounted to 91,522 tons, and exports totalled 506,879 tons, while 99 tons were imported. Exports in primary forms were valued at $197.66 million and in semi-fabricated form at $9.15 million. Exports of aluminum scrap were valued at $4.2 million, aluminum foil at $951,000, aluminum manufactures at $770,000 and kitchen utensils at $34,600.

Imports the same year were 199,-800 tons of alumina valued at $3.74 million; 2.89 million tons of bauxite valued at $20.8 million; 3400 tons of cryolite valued at $752,600; and aluminum metal in various forms valued at $20 million. The price of aluminum ingot at the end of 1955 was 21 cents per pound. The U.S. import tariff on aluminum metal and alloys was 2 cents per pound. The U.S. price in December 1955 was quoted at 24.4 cents per pound.

Current Expansion Program

The Kitimat plant commenced operations in the summer of 1954 at a rated capacity of 90,000 tons per year. In October of that year a further expansion of 60,000 tons was authorized, while under the 1955 program new capacity would come in over a period extending late into 1959, bringing the Company's total Canadian capacity to 900,000 tons of ingot per year commencing in 1960.

During 1956, 90,000 tons of new capacity was brought into operation at Kitimat. More than 3000 persons were employed at year's end on townsite and smelter construction. Two new hydro-electric generators, each of 150,000 horsepower capacity, were added during the year at the Kemano power plant. The present generating capacity of 828,000 horsepower can support an ingot capacity of 225,000 tons yearly.

Currently the Company is adding a new power development in the Saguenay district, which will add some 700,000 h.p. to the firm power output of the Saguenay system as a whole. First production will commence in the summer of 1959. Concurrently ingot capacity at Arvida and Isle Maligne is being increased by 150,000 tons. If plans both in the west and the east proceed, total ingot capacity will slightly exceed one-million tons in 1960.

By the summer of 1957 the Jamaica alumina plant will have a capacity of 550,000 tons, and a second plant now under construction will add a further 250,000 ton capacity.

The Canadian-British Aluminium Company Ltd., is building a $130-million plant for production of primary aluminum near Baie Comeau, Que. The project, which ultimately will produce 320 million pounds of ingot yearly, will be developed in four stages, the first stage scheduled for production in 1958 and the entire project by 1965. Power is being developed on the Manicouagan river jointly by the Company and North Shore Paper Co. Ltd.

The Aluminum Products Industry

This industry comprises the operation of factories occupied chiefly in the fabrication, casting or rolling of aluminum to make bars, sheets, wire, cable, foil, cooking utensils, etc. It does not include primary aluminum smelting or castings, cable, utensils, and so on, made as secondary or minor products, or brass or iron foundries.

The value of shipments for 1955 totalled some $79.8 million, practically the same as for 1954. Employment in 1956 averaged 6834 persons compared with 7000 in 1954. The value of shipments in 1956 totalled $84.73 million; 6 per cent higher than for 1955.

In 1954, the last year a full report was issued, there were 99 factories, 25 in Quebec, 61 in Ontario, one in Manitoba, 5 in Alberta, and 7 in British Columbia. Materials purchased were valued at $46 million and factory shipments were valued at $80.5 million.

Value of the various categories of production in 1954 in millions of dollars was as follows: cooking utensils, $7.5, while other industries made aluminum ware worth $0.45 million, bringing the total to $7.95 million. Output of extruded shapes, $7.09; utensils $7.5; castings, $5.2; castings (other), $1.02; die castings $0.63; other products such as ingots bars, rods, foil, forgings, tubing and cable $59.0.

Right, the Consolidated Mining and Smelting plant at Trail, B.C.

Below, the smelter at Kitimat, B.C., of the Aluminum Company of Canada Limited.

MACHINES AND EQUIPMENT

The machinery industry covers operations of iron and steel works occupied chiefly in making industrial, household, office and business machinery and machine tools. (Farm implements and electrical machinery are covered elsewhere.) Some concerns in other groups made machinery as secondary or minor products, so production figures do not represent the total output of the commodities listed.

Products made in this industry include household and office machinery, conveying, transmission and elevating machinery, machinery for the pulp and paper, mining and metallurgical, road making, logging, lumbering, woodworking, and grain handling industries, and machinery for service stations, firefighting and refrigeration, as well as hydraulic turbines, pumps, elevators, air compressors, furnace blowers, power shovels, steam and diesel engines.

As defined above, this industry included 399 firms in 1954, the most recent year for which full statistics are available. These establishments employed 32,851 persons in 1954, 20,000 of whom were in Ontario, 10,000 in Quebec, 1500 in British Columbia, with the balance divided between five other provinces. Materials purchased were valued at $131 million and gross production totalled $342.3 million, practically the same as production for the previous year.

According to preliminary DBS reports, production in this industry during 1956 was estimated at some $366 million.

A broader classification covering the entire machinery production in Canada, as assembled from all industries, including as well as the categories listed above: motors, generators, electric washers, refrigerators, dryers, oil burners, knitting machines, typewriters, welding machinery, accounting and calculating machinery, is also recorded in the statistical report for 1954. During that year the value of this total production for the entire group totalled $503.8 million. For this broader group no preliminary estimate of 1956 production was available before this publication.

Manufacture of heavy machinery and equipment under way in 1956 included two 100-ton extrusion presses for aluminum alloy; calandria for the NRU reactor for Atomic Energy of Canada Ltd.; waste heat boilers for the City of Montreal; a rotary kiln 12 ft. diam. and 450 ft. long; a rotary ball mill 13 ft. x 16 ft.; hydraulic actuating cylinders; a Churchill roll grinder 63 inches by 408 inches; as well as many hydraulic turbines of various capacities up to 150,000 horsepower.

To these should be added landing gear of ultra-high-tensile steel for the CF-100 and other assemblies for aircraft industry; compressor parts, vessels for oil refineries; a large high temperature stress-relieving furnace 18 ft. x 18 ft. x 82 ft.; and a new radial drill with 10 ft. arm and a 29 in. dia. column.

FARM IMPLEMENTS

Although total farm cash income for the first three quarters of 1956 showed an increase of some 11 per cent over the previous year, the value of shipments of farm implements and equipment over the same period indicated a lower volume of sales than for 1955. No estimate of 1956 sales was available for this survey.

Canadian sales of farm implements and equipment during 1955 amounted to $155.1 million, an increase of 5.7 per cent over 1954, but only some 62 per cent of the peak sales volume of $250.2 million experienced in 1952. Sales of repair parts in 1955 increased 4 per cent to $28.45 million.

Half of all types of farm implements and equipment were sold in the three prairie provinces. Dollar values as quoted are wholesale prices, and information submitted to the Dominion Bureau of Statistics indicates an average retail markup of 22.3 per cent for implements and equipment and 33.3 per cent for repair parts.

Sales volumes for major groups in millions of dollars were as follows: tractors and engines $58.7; harvesting machinery, $27.7; haying machinery, $21.7; ploughs, $8.22; water systems and pumps, $7.8; tilling, cultivating, and weeding machinery, $7.0; planting, seeding and fertilizing machinery, $5.35; machinery for preparing crops, $4.8; dairy machinery and equipment, $3.9; barn equipment, $2.6.

Purchases in the prairie provinces by groups amounted to the following percentages of the total for all Canada: tractors and engines, 46%; harvesting machinery, 78.6%; haying machinery, 44.5%; ploughs, 65.8%.

HARDWARE, TOOLS AND CUTLERY

The hardware, tools and cutlery industry enjoyed a year of record production in 1956, with production valued at some $191 million according to preliminary estimates, compared with production valued at $132.5 million in 1955, an increase of 44 per cent.

For a full description of the industry we must look back at the year 1954, the last year for which full statistics are available. That year there were 379 establishments in Canada with employment of 13,264 persons, 971 of them in Ontario, 2900 of them in Quebec and most of the remainder in British Columbia. These firms purchased materials valued at $40.1 million, added a value of $77.3 million by manufacture, and produced goods with a gross selling value of $118.5 million.

Output included bolts, nuts, rivets, hardware, razors, saws, screw machine products, metal stampings, twist drills, milling cutters, machine knives, axes, hatchets, spades, forks, shovels, carpenters' tools, etc. Razors and cutlery produced were valued at $5 million; hardware at $26 million; hand implements at $3.4 million; tools and dies at $4.4 million; hand tools and small tools at $20.2 million; and bolts, rivets, dies, saws and miscellaneous products, $59 million.

The quantities of some of the principal materials used in manufacture during 1954 were as follows: steel bars and rods, 30,000 tons; sheets, 12,000 tons; wire, 14,000 tons; strip, 7,000 tons; plates, 2,260 tons; structural shapes 1,300 tons; bronze and brass 2,000 tons; aluminum 1,900 tons; zinc, 800 tons; copper 170 tons; lumber 2,277 M fbm.*

The industry's capital and repair expenditures during 1954 amounted to $10.17 million, approximately the same amount as during the previous year.

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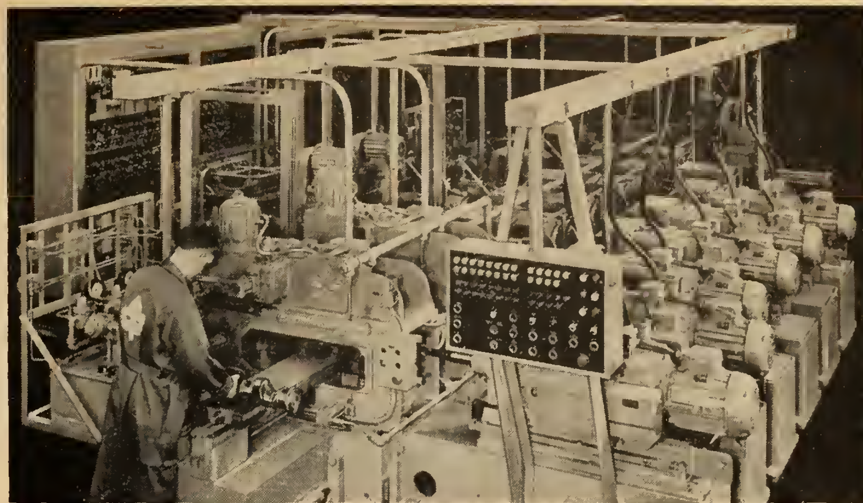
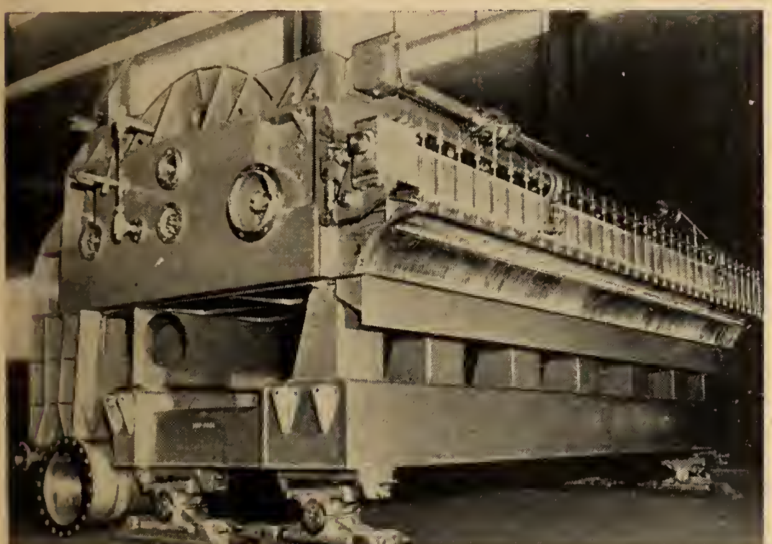
*Foot board measure.

RAILWAY EQUIPMENT

THE RAILWAY rolling stock industry includes all establishments chiefly occupied in making railway cars and locomotives or parts for same such as wheels, brakes, tires, bolsters, springs, etc. The principal repair shops of the CNR and CPR are also included.

Shipments of railroad and rolling stock equipment in 1956, according to preliminary reports from the Dominion Bureau of Statistics, were valued at some $356 million. This included 439 diesel locomotives and 8633 railway cars for the Canadian National and Canadian Pacific Railways.





Above is an example of the machine tools made by the industry in 1956. This is an 11-station transfer machine for the British automobile industry; the machine does 36 operations on automotive crankshafts. *(Photo: Gordon Rice, Standard Modern Tool Company Limited.)*

The pulp and paper industry is a large user of heavy machinery. At left is the pressure head box for the new No. 9 newsprint machine of Powell River Company. *(Photo: Dominion Engineering Works Limited.)*

The Banbury mixer, below, was installed in 1956 at the Phillips Electrical Company plant at Brockville, Ont. The machine mixes 500-lb. batches of rubber compound and extrudes it in strips which are used for various electrical applications.

Production in 1954, the last year for which a full report is published, showed a value of $283.4 million, 16.2 per cent lower than for 1953. Output included 8527 railway cars valued at $88.4 million and 244 diesel locomotives valued at $41.1 million.

Thirty-six firms were in operation in this group in 1954; sixteen in Ontario, eight in Quebec, four in Manitoba, three in Alberta, three in Nova Scotia, and one each in New Brunswick and British Columbia. Employees numbered 29,214. Employment had more than doubled since 1933, while gross selling value of production had more than doubled since 1946. Half the employment was in the province of Quebec, mainly due to the CNR and CPR shops in Montreal.

Materials used in manufacturing or repairs cost $162.2 million. The main items purchased in 1954 included

iron and steel valued at $29 million, car and locomotive parts valued at some $54 million, brass and bronze valued at $4.4 million, lumber valued at $3.2 million. Capital and repair expenditures for the year amounted to some $18 million, compared with an average of $20 million annually over the previous four years.

Imports of cars, locomotives and parts for same during 1954 amounted to some $44 million and exports to some $8.5 million.

ELECTRICAL EQUIPMENT

Electrical manufacturing has joined the ranks of Canada's billion dollar industries with a record production of $1,100 million in 1956, five per cent higher than for the previous year. Employment in the 475 establishments operated by the industry also has risen to a new high of 80,000. Year-end inventory held amounted to $126 million for finished products; $149.7 million for goods in process and $111.5 for raw materials; a total of $387.1 million, compared with $343.5 million at the end of 1955.

The industry is now capable of producing almost all of Canada's electrical requirements. Imports of electrical apparatus and supplies have been steadily rising, from $82 million in 1948 to an estimated $450 million in 1956. This growth, added to the steadily growing production of supplies and apparatus in Canada resulted in a market of $1.5 billion in 1955 and a market estimated at $1,550 million in 1956.

Industry Statistics for 1954

In 1954, the latest year for which a full report was published, the industry employed some 75,000 persons, purchased some $397 millions worth of materials, added a value of $463 million by manufacture and sold products at a gross value of some $864 million. Selling value by subgroups, in millions of dollars, was approximately as follows: miscellaneous products 268; radios and parts, 228; heavy electrical machinery, 202; refrigerators and appliances, 130; and batteries 35. Opening inventories for that year amounted to $229 million, and closing inventories to $208.5 million.

Value of factory shipments during 1954 was divided between seven provinces as follows: from Ontario, $636.6 million; from Quebec and Nova Scotia, $207.8 million; from Manitoba and Saskatchewan, $9.4 million; from British Columbia, $9.1 million; and from Alberta, $1 million.

Imports during the year of some of the principal commodities used in manufacture, in order of value and expressed in millions of dollars were: radio and wireless apparatus 58; electric apparatus and parts, 23; refrigerators, 17.7; rheostats and starting and controlling devices, 15.7; electric motors, 12; radio receiving sets, 11; switches, switchboards and circuit breakers, 10.7; telephone apparatus, 10.5; heating and cooking apparatus, 9.5; radio tubes, 8.8; electric irons and parts, 8.4; and air conditioning apparatus, 8.2.

Exports of selected commodities during the year, in order of value and expressed in millions of dollars, were: radio and wireless apparatus, 6.8; electrical apparatus (n.o.p.); 3.7; dynamos and generators and parts, 2.4; spark plugs, 2; telephone and telegraph apparatus, 1.8; radio receiving sets, 1.5; meters and parts, 1.4.

1954 value of production was down from the previous year for refrigerators, ranges, washing machines, sharply down for radio receiving sets, but slightly higher for batteries.

Values of some of the principal materials used by the industry in 1954, expressed in millions of dollars, were approximately as follows: copper and products 56.7; radio and T.V. parts, 45; iron and steel and their products, 31; radio and T.V. tubes 23; radio and T.V. cabinets, 14; lead and products, 12; alloy steel, 8; brass and products, 7; containers, 7; glass bulbs, 3; cotton and linen, 2.8; paint, 2.5; insulators, 1.8; rubber and products, 1.5; lumber, 1.6; and steel tanks, $1.2 million.

Rate of Profits Won't Support Expansion

Although the industry faces almost unlimited opportunities due to the nation's rapid development of hydro-electric power, this imposes a responsibility upon it to risk large investments in expansion, modernization, and the development of manpower. The industry's current net earnings, however, will not support these necessary expenditures.

Keen competition among domestic producers and rising labour and material costs, together with competition from prices for imports, have kept returns on capital unreasonably low. The 2.9 cents net profit on the electrical sales dollar in 1955 was discouraging compared with the average profit of 5.9 cents for all manufacturing industry. Though profit in 1956 will be somewhat higher, it will still be below the level necessary for a 'growth' industry.

Some Segments Show Spectacular Growth

Performance for the entire industry, however, cannot be taken as a reliable measure of performance for each part or for any particular category. Nor does the performance of one manufacturer in any production line measure reliably the performance of all producers of the same type of goods.

Member companies of the Radio-Electronics-T.V. Manufacturers' Association, for example, increased the value of factory shipments of manufactured goods from $20 million in 1939 to $505 million in 1955. While the gross national product only doubled, the electronics industry increased sevenfold in ten years. During 1956 the telephone companies spent $320 million on plant compared with $279 million in 1955 and $249 million in 1954.

All Major Industries Need Apparatus

During 1956 the apparatus segment of the industry had a record volume of orders from Canadian utilities and industries. The steel industry is carrying out a record expansion program to increase capacity. The pulp and paper industry is adding new mills and expanding existing mills. Uranium mining is opening up new areas of expansion. Oil and gas pipelines are placing large orders for apparatus. The installation of an additional 1,350,000 horsepower by Canada's power companies last year called for vast orders of new apparatus for generation transmission and distribution of electrical energy, and for the industrial equipment to put it to work.

1957 Emphasis is on Consumer Spending

Looking ahead, the apparatus segment foresees another record volume of orders in 1957 from Canadian utilities due to the sharply expanding use of electrical energy. But where the dominant force in 1956 came from business capital spending, the emphasis in 1957 is expected to shift to consumer spending.

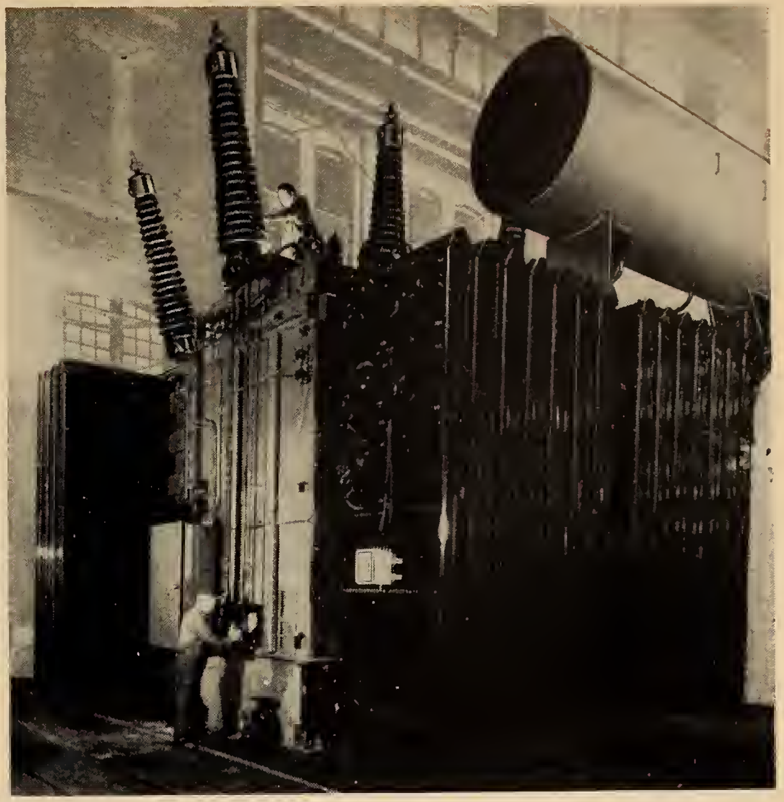
Though increases for staples such as ranges and refrigerators may not be spectacular, newer, low-saturation appliances such as laundry equipment, dishwashers, electronic ranges, air conditioners and dehumidifiers, will show substantial gains. The increasing application of electronic apparatus will be a major factor in the growth of the industry, placing it among the fastest growing manufacturing industries in Canada.

More Home Appliances and Better Wiring

The average consumption of electricity per residential customer rose from 1,423 kilowatt hours in 1939 to 3,750 kilowatt hours in 1956. Some 94 per cent of the four million occupied dwellings receive electrical service. Three million more will be added over the next 25 years, and *per capita* domestic consumption per year will continue its steady rise.

A long range program has been launched to convince the public of the need for better wiring in homes, business establishments and industrial plants. Initiated by electrical manufacturers, it will be developed in co-operation with provincial electric service leagues and with utilities, dealers, distributors, contractors and inspectors.

To emphasize the immediacy of the program, industry spokesmen are pointing out that most Canadian homes lack sufficient electrical outlets to operate more than a small portion of the more than 70 household electrical appliances now available to the consumer.



Heavy electrical equipment for the power industry is exemplified by this 300-ton autotransformer built for Hydro-Quebec's Bersimis development.

Rapid Growth in Electronics

The electronics business has had spectacular growth in post-war years, growing to a half-billion dollar industry. Sales of T.V. and radio receivers, radar and other electronic equipment for defence purposes, closed circuit T.V., electronic computers and other devices added up to more than $500,000,000 in 1956. To this must be added considerable volume sales of the phonograph and records industry based on electronics. The growth of electronics is only beginning. Hundreds of operations now done mechanically and electrically will be operated electronically in the future.

Among the engineering facilities for the improvement of electrical equipment is a new environmental laboratory, of which the vibration test area is shown below. The laboratory is equipped with a stratosphere chamber and with equipment to subject electronic and mechanical components to impact, vibration, and sustained acceleration tests. *(Photos: Canadian Westinghouse.)*

Television production, though sales were down some 13 per cent in 1956, has grown faster in Canada than any other country in the world, becoming as dominant in the home as radio was five years ago. The trend towards high-fidelity play, greater convenience and lower cost, and purchase of the small 45 records and 'long-plays' is expected to continue many years.

In rolling of steel, aluminum, tin, and paper, electronics measures the precise thickness of material and automatically adjusts the rollers to keep the required thickness to very minute tolerances, in some instances to an accuracy of 1/10,000th inch.

Equipment for fighter aircraft, radar lines in the north, and various communications systems for all services is designed and built in Canada's electronic plants. Canada can justly claim a leading position among nations of the world in making use of electronic weapons and devices.

In Quebec province one of the longest industrial microwave communications systems was placed in operation between Montreal and Bersimis. Other systems, shorter but similar, are being installed in three western provinces.

Many New Uses on Horizon

Closed-circuit T.V. is beginning to come into industrial use in Canada. Its use will mushroom as automation of industries goes on. Electronic stoves, refrigerators and air conditioners are products of the very near future. Modern appliances, electronically operated, will require less space, will have no moving parts, and will be more convenient and much less expensive to operate.

Control, measurement and manipulation of radioactive material for nuclear generators rely solely on complicated electronic equipment. Successful atomic power development lies in the discovery, not yet made, of suitable 'direct' means of converting radioactivity into electricity without making steam to drive turbines.

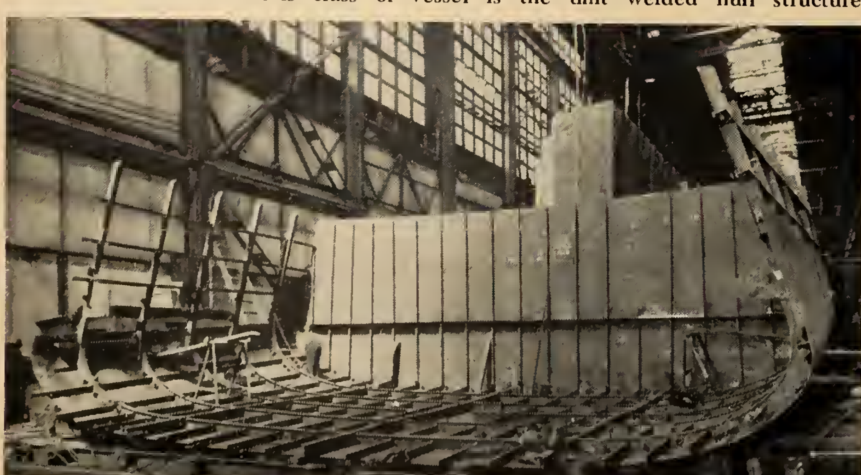
Electronics has now demonstrated the possibility of converting solar energy directly into the form of electricity which can be stored for cloudy periods. It is already done by R.C.A. on a pilot scale.

SHIPBUILDING

The canadian shipbuilding industry was only moderately active during 1956. Satisfactory progress was made on the Navy's current shipbuilding program, the most ambitious ever undertaken in Canada. Without the naval program however, the year would have been difficult and uncertain for many of the shipyards. This building program, commenced in 1949, is now well advanced and will be completed in 1958, with no assurance of its being extended.

Only some 27 ocean going vessels are left on Canadian registry. Nearly all Canadian-owned deep sea vessels have been transferred to British registry because, under the Canadian flag, the wages their owners are obliged to pay make it impossible to compete with British and foreign ships with wage scales half as high. Nor do Canadian operators feel they can build ocean going ships in Canada unless the Canadian government gives some assistance to offset the high level of shipyard wages.

The hull of HMCS *St. Laurent* during construction at Canadian Vickers Limited, Halifax. A feature of this class of vessel is the unit welded hull structure.



Production in 1954

In 1954, the last year for which complete statistics are available, Canada had 76 shipyard establishments, with total employment of 19,356 persons. They purchased materials valued at $56.2 million, added a value by manufacture of $98.6 million and showed production totalling a gross selling value of $156.6 million. This compared with 75,847 employees and production valued at $376.5 million in 1943, the most active year in the industry's history.

The industry, as recorded in Bureau of Statistics reports, includes all establishments occupied in making commercial or naval vessels, plus yards doing ship repair work or outfitting ships for delivery. Naval dockyards on Canada's east and west coasts are not included though considerable repairs and overhauling are done there.

Completions in 1956

Completions for the Navy in 1956 included three Canadian-designed destroyer-escorts, one minesweeper, and an ocean-going tug. Three barges, a lighthouse tender, and a survey vessel were built for federal government departments other than Defence. Thirty-eight ships were also completed for domestic commercial owners; of these, four 'canallers' and one ocean-going tug were the only ones over 1000 gross tons. The remaining 33 were barges, scows, tugs, and dredges, ranging from 25 to 1056 registered tons, the largest being for use on the Pacific coast.

Outlook Moderately Improved

Toward the end of 1956 there were signs that the industry was beginning to cash in on the world shortage of deep sea ships. Shipyards that are members of the Canadian Shipbuilding and Ship Repairing Association estimated there were about 14,300 persons employed in their yards compared with some 12,800 at the beginning of the year. Officials of the Canadian Maritime Commission estimated Canadian shipyards had orders on hand for some $48 million worth of commercial shipping, well ahead of the backlog at the end of 1955.

This improvement was primarily due to the Suez crisis which had

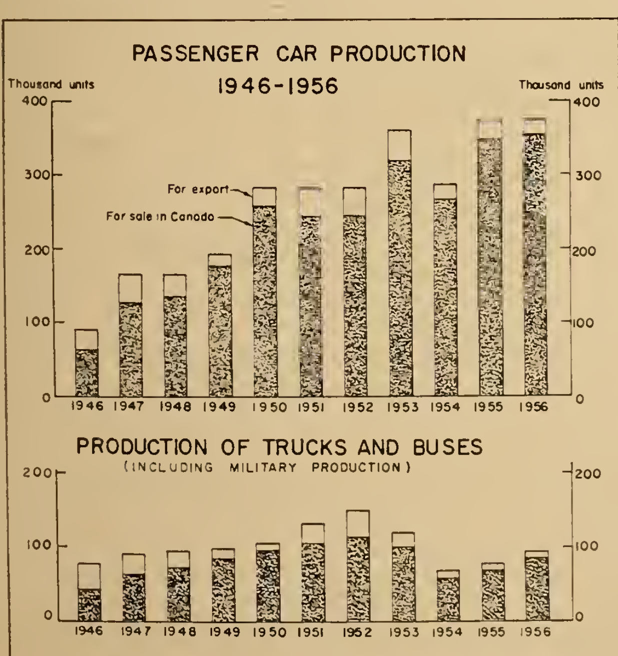
A general view of the yards of Davie Shipbuilding Limited, at Lauzon, Que. Vessels of 28,000 tons have been built in these yards. Fabricating of industrial equipment is also carried out in new shops.

stimulated demand on shipbuilders around the globe, particularly for large tankers and bulk carriers. Completion of the seaway is also expected to bring orders for some big vessels. Unfortunately the scarcity of steel is preventing Canadian yards from promising early deliveries.

What the future holds in orders for ships for the coastal trade depends on the findings of Canada's Royal Commission on Coasting Trade, and on the government's decision on its recommendations. If, after deepening the St. Lawrence, Canada permits shipowners to build ships in the United Kingdom for Canadian coasting trade, it will be disastrous for the Canadian shipyards. Many Great Lakes operators, uncertain of the future, are delaying orders until this question is settled.

MOTOR VEHICLES

The canadian automotive industry made its biggest contribution to the Canadian economy in 1956, with peak employment at 37,225 and shipments of about 475,000 automobiles and trucks with a retail value of $1.4 billion. This sales volume raised total registrations in Canada over the four million mark, including 3,200,000 passenger cars and 1,000,000 commercial vehicles. The 375,000 passenger cars and 99,255 commercial vehicles produced compare with 375,000 and 78,569 trucks produced in 1955. Percentage shares of production were: General Motors, 39.7; Ford of Canada, 29.7; Chrysler, 24.7; Studebaker, 2.2; and American Motors, 1.5.



Most of the industry's gain in 1956 over the previous year can be attributed to the strong comeback of the market for trucks. Factory shipments of Canadian vehicles built for export likewise showed a gratifying increase from 35,000 in 1955 to an estimated 38,000 in 1956. Sales of some 425,000 passenger vehicles and 100,000 trucks appear possible for 1957 and could be achieved without straining the industry's capacity.

In 1955, latest year on which full figures have been published by the Bureau of Statistics, fifteen establishments employing 33,429 persons purchased materials valued at $631 million, added a value of $269.6 million by manufacture, and produced vehicles and parts with a gross selling value of $907.4 million; 68,629 of the trucks and 9,383 of the passenger cars produced that year were exported.

During 1955, 9,600 vehicles were exported to South Africa, 3600 to Australia, 2400 to New Zealand, with all other countries receiving the remaining 3000 in lots of 377 or under. Shipment of cars in 1955 was divided between 224,357 4-door sedans, 70,835, 2-door sedans, 30,600 hard-top convertibles, 17,000 station wagons, 13,345 chassis without bodies, 9700 5- or 6-passenger coupés, 2600 soft top and 15,300 other models. Shipments of trucks included 39,784 of gross weight 5000 pounds and under; 11,624 of weight 5000/10,000 pounds, 4088 of weight 10,000/14,000 pounds, 9395 of weight 14000/16000 pounds, 9239 of weight 16000/19500 pounds, 3391 of weight 19500/26000 pounds, and 491 of weight over 26000 pounds. Buses included 333 transit type and 224 chassis.

Imports during 1955 included 4681 freight automobiles, 19,989 passenger automobiles valued at under $1200 each, 8981 passenger autos valued at over $1200 each, 292 motor buses, and 9539 of all other types of passenger vehicles.

In 1955, motor vehicle registrations for all Canada totalled 3,948,787, of which 2,935,412 were passenger automobiles, 938,115 commercial vehicles, 39,007 tractors and 36,253 motor cycles. During the year withdrawals from use were estimated at 150,883 passenger vehicles and 20,730 commercial vehicles.

AIRCRAFT

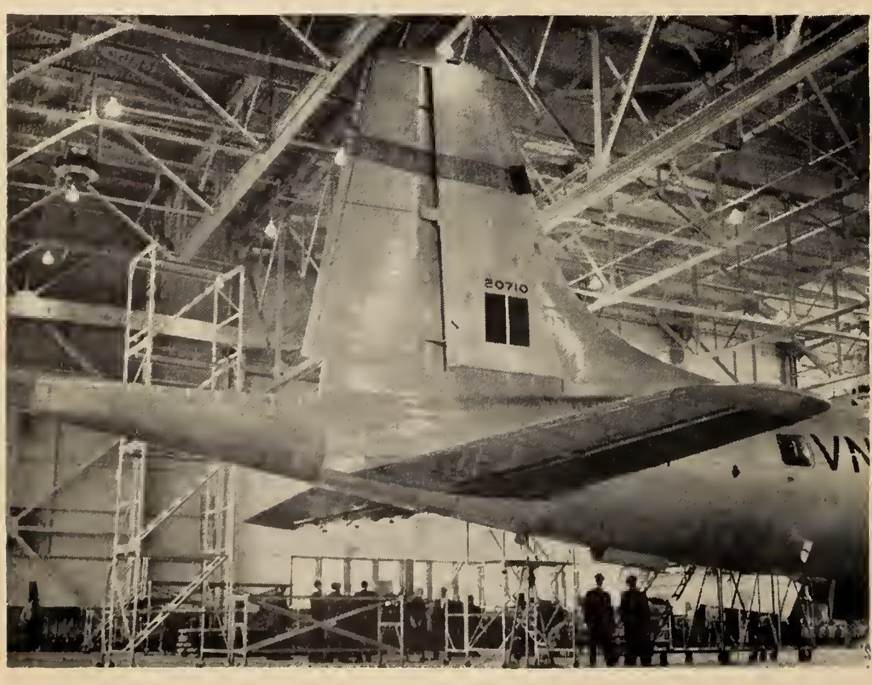
For Canada's aviation manufacturing industry, 1956 was a year of solid accomplishment and one of achievement in production, design and engineering. Ranking third among Canada's manufacturing industries in the number of employees and ninth in the value of sales, the aircraft and parts industry in 1956 maintained employment at close to the 1954 total of 35,000, though total value of production rose to some $360 million.

In 1954, the most recent year for which full statistics are available, forty-three parts plants and four assembly plants produced aircraft and parts valued at $343 million. During that year the industry purchased $158.9 million worth of materials and added $181.4 million value by manufacture. Production was 15 per cent lower than in 1953.

Production in 1956 was only exceeded by the peacetime record year of 1953, when 38 establishments employing 33,356 persons showed production valued at $398.7 millions, and by the wartime record year of 1944 when 45 establishments employing 79,572 persons showed a production valued at $427 million.

Today, Canada's four assembly plants are Canadair Limited, at Montreal, Avro Aircraft Ltd., and de Havilland Aircraft of Canada Ltd., Toronto, and Canadian Car and Foundry Co. (controlled by Avro Aircraft) at Ft. William. Among the 43 parts plants, outstanding are: Orenda Engines Ltd.; Canadian Steel Improvement Ltd.; Bristol Aeroplane Co. of Canada (1956) Ltd.; Bristol Aero Engines Ltd.; Bristol Aircraft Western, Ltd.; Canadian Pratt and Whitney Ltd.; Fleet Manufacturing Ltd.; and Rolls Royce of Canada, Ltd.

The largest aircraft so far built in Canada is the RCAF maritime patrol *Argus*, derived from the Bristol *Britannia*. The tail stands some 37 feet above the hangar floor at the Montreal plant of Canadair Limited. (*National Defence Photo.*)



Major Accomplishments in 1956

The year 1956 saw the birth of a new Canadian-designed and produced jet engine, Orenda's "Iroquois," It saw near-completion of Canadair's submarine-reconnaissance CL-28, an adaptation of the Bristol 'Britannia', the largest aircraft ever built in Canada. A start was made on quantity production at de Havilland of the Grumman CS2F-1, and commencement of production of the Wright R1820 by Canadian Pratt and Whitney, Ltd.

Avro Aircraft is working on a 'mock-up' and tooling for the CF-105, with the first unit to be produced by mid-1957. Work on the delta-wing supersonic CF-100 is continuing. The company is also working on 'Project Y' V.T.O. aircraft designed and developed on a U.S. airforce contract.

De Havilland Aircraft has started production of the Grumman CS-2F-1 for the Canadian Navy, and has orders for 60, with spares for 100 units. The same company is developing a twin engine transport known as the DCH4 which will be named the 'Caribou'. This will be launched with piston driven Pratt and Whitney engines but later may be powered with turbo-prop engines. It will have a 5000 pound payload and a take-off and landing run of 5000 feet.

Canadair, Ltd., beside the 75 'Sabres' it is building for the Canadian government for West Germany, has export orders from Colombia for 6, and from South Africa for 34. While production of Sabres and T-33 jet trainers is down to a few per month, the company has an order for 25 of the CL-28 reconnaissance aircraft. The CL-44, being developed from it, will replace the R.C.A.F.'s present North Star transport fleet, and may also conceivably be adapted to commercial use.

The company is also designing and building a nuclear research reactor for Atomic Energy of Canada, Ltd. A sizeable order from Republic Aircraft for tooling for the F-105 has been received; as well as subcontract work from de Havilland and Avro, and the building of airframes for Velvet-Glove air-to-air missiles. Design for a small jet trainer has been completed and is under consideration by Ottawa.

The Canadian Car and Foundry Co. Limited aircraft division is fabricating the complex wing assemblies of the Grumman CS2F-1 for de Havilland, as well as wing-and-tail-assemblies for the 'Otter'. Bristol Aircraft (Western) Ltd., formerly MacDonald Brothers Aircraft of Winnipeg, is preparing to build an anti-submarine version of the Bristol 191 twin-rotor helicopter for the Canadian Navy.

Canadian Pratt and Whitney, Ltd., is undertaking a $5 million expansion program. Fleet Aircraft is doing sub-contract work on wheel-ski assemblies for 'Beavers' and 'Otters' and on wing extensions for the CF-100 Mark 5.

Orenda Engines, Ltd. successfully completed the first 50 hour flight test on the new 20,000-plus h.p. PS-13 'Iroquois' jet engine. The engine will be flight-tested on a modified B-47 and will power the new Avro CF-105 interceptor. Production of 'Orenda' engines is still proceeding at a reduced rate.

The latest version of the Canadian-designed CF-100 interceptor is the Mark V *Canuck*. During 1956 progress was made with the supersonic Avro CF-105 delta interceptor, which will eventually replace the CF-100. *(National Defence Photo.)*

ASBESTOS

Shipments of asbestos from Canadian mines during 1956 amounted to 1,017,848 tons, compared with 1,062,000 tons the previous year. Exports at 964,000 tons were also lower than the 1,001,800 tons in the previous year. Productive capacity for the industry reached a new high level, however, as the result of the expansion during the past few years.

The moderate drop in production was due primarily to competition from fibre of Russian origin shipped to European countries under barter or other trade agreements. A moderate decline in construction activity and automobile production in the United States which takes some 60 per cent of Canadian asbestos sales volume also contributed to the decline. Shipments to Britain were also affected by credit restrictions. On the other hand, shipments to Japan recovered to almost their prewar level.

Winding pipe-covering sections made of corrugated and flat asbestos papers. *(Photo: Canadian Johns-Manville Limited.)*

In 1956 there was a fall in demand for spinning grades, but in the relatively more important market for medium grades there was a definite increase in demand, reflecting world wide expansion in the asbestos cement products industry. Short fibres continued to move well, though not quite at the high level of 1955.

The largest producing area continues to be in the Eastern Townships area of Quebec in the vicinities of Thetford, Black Lake East, Broughton, and Danville. Ontario's production comes from Munro Tp., while British Columbia production comes from the Cassiar district. Canada leads all nations in volume of production, with some 60 per cent of world output. Soviet Russia and the Union of South Africa come next in that order.

Asbestos Products Industry

Asbestos has a variety of industrial uses. The longer-fibred spinning material is formed into textiles, and into packing, insulating, and heat-resisting frictional materials. Other fibres are used in the asbestos cement industry for production of pipe, shingle, tile, millboard, siding, roofing, etc., and for the production of asbestos paper. The short fibred material is used in protective coatings, plastics, in lubricating greases and in some specialized applications as an industrial filler. 1955 price quotations per ton were crude no. 1, $960/1500; crude no. 2, $595/900; spinning fibres, $321/514; shingle fibres, $150/200; paper stock, $109/137; waste, $77; and shorts, $35/70.

Production in 1955

In the most recent full statistical report of the industry published for the year 1955, it was stated that 30 mining establishments employed a total of 6729 persons, purchased supplies and containers valued at $11.18 million, and had an output valued at $83.8 million. During the year 17.7 million tons of rock were mined and 12.4 million tons were milled.

Selling values at shipping points for the various grades, exclusive of value of containers, were as follows, in millions of dollars: group 4 (shingle), $36.6; group 7 (refuse), $17.4; group 3 (spinning), $16.0; group 5 (paper), $12.8; group 6 (stucco), $12.25; crude no. 1, no. 2, and other, $0.61; group 8 (sand), $0.46.

Exports during the year included products valued as follows, in millions of dollars: milled fibres, $63.4; waste, refuse and shorts, $30.9; asbestos, $0.48; brake lining facings $0.37; and packing, $0.04; a total value of $97.7.

Imports for the year were valued at $4.05 million, nearly three quarters of which were classified as 'asbestos in any other form than crude, and all manufacturers'.

CEMENT AND CONCRETE

PRODUCTION OF Portland cement in Canada during 1956 amounted to 29.56 million barrels, an increase of 16 per cent over the 1955 production of 25.18 million barrels, while stocks at plants and warehouses at year-end amounted to 1.63 million barrels. During the year 3.2 million barrels were imported.

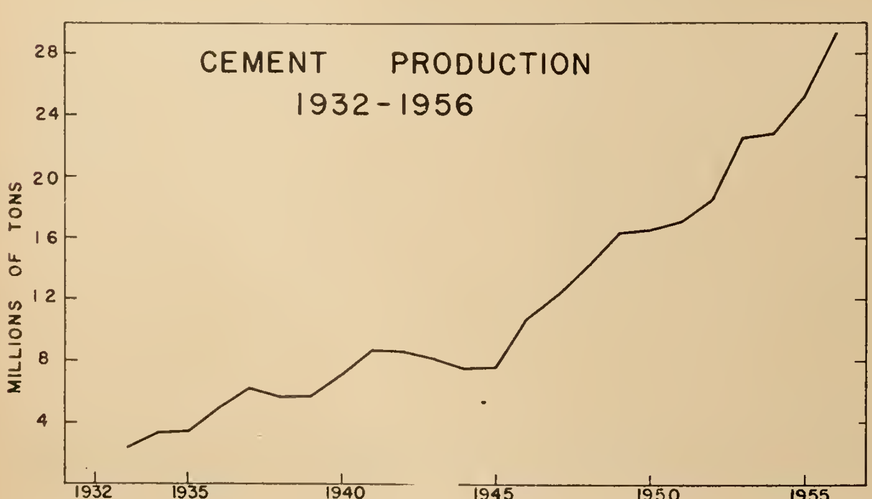
During the year 102.5 million concrete bricks were produced, compared with 130 million the previous year, while 102.5 million were shipped. Production of concrete blocks other than chimney blocks amounted to 109.7 million, with 118.4 million shipped. Production of concrete chimney blocks amounted to 879,000 with 862,000 shipped. Production of cement pipe for drains sewers, culverts and water totalled 551,900 tons , with 553,700 tons shipped. Production and shipments of ready-mix concrete totalled some 4,987,000 cubic yards.

Production of concrete brick for the year was 21 per cent lower than in 1955. Production of all types of concrete blocks was slightly lower than in 1955. Production of concrete pipe was 30 per cent higher than in 1955, while yardage of ready mix concrete also exceeded 1955 production by some 30 per cent.

These figures represent production by the principal manufacturers, which normally account for 85 per cent of the total Canadian output of concrete products and which have not been expanded.

Pattern of the Cement Industry

The cement manufacturing industry in 1955 (last year for which a full report has been published) consisted of 12 plants with combined employment of 2800 persons. These plants purchased materials, containers, and process supplies valued at $11.5 million, while value of production f.o.b. works amounted to 144.3 million. There were 29 kilns in all, with a total capacity of 70,900 barrels per 24 hours.



Imports and exports of cement both increased in 1955. The apparent consumption as computed from shipments, plus imports, less exports amounted to 27.16 million barrels as compared with 24.6 million barrels in the preceding year.

Producers' shipments by provinces, in millions of barrels, for 1955 were as follows: Quebec, 9.5; Ontario 7.66; Alberta, 2.8; Manitoba, 1.94; British Columbia, 1.9; Newfoundland 1.47; and New Brunswick, 0.47. Raw materials consumed during the year included 6 million tons of limestone, 219,500 tons of gypsum, 798,700 tons of clay, 91,400 tons of sand, 71,600 tons of shale, 23,740 tons of iron oxides, and varying amounts of other additives. 501,600 tons of Canadian coal and 325,350 tons of foreign coal were used, as well as 491 million kilowatt-hours of electricity.

During 1955 the St. Lawrence Cement Company brought a new plant into production at the beginning of the year while Canada Cement Company expanded its plant at Fort Whyte in Manitoba. Inland Cement brought a new plant into production at Edmonton early in 1956. Construction of a fourteenth mill will be commenced in 1957 at Vancouver costing one-million dollars.

In 1953 Canada held tenth place among nations of the world in production of hydraulic cement.

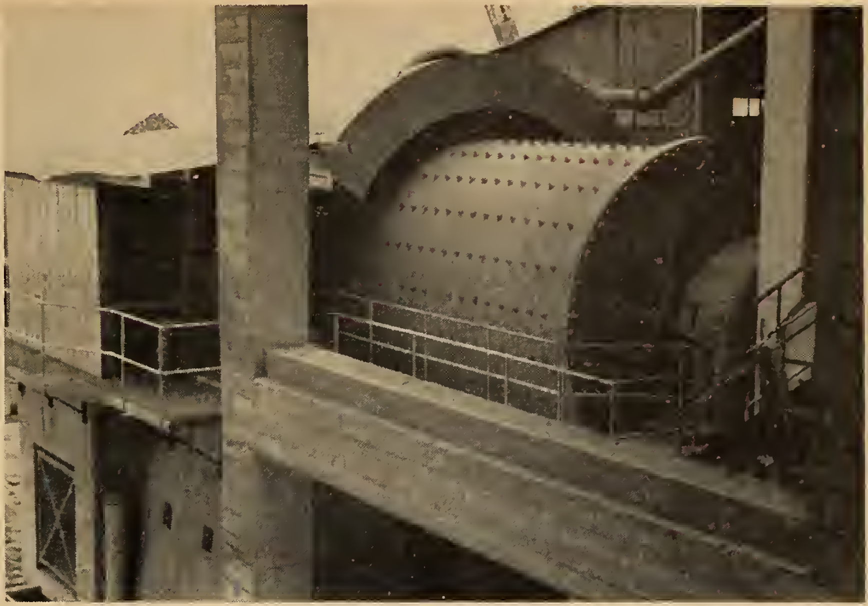
Pattern of the Concrete Products Industry

In 1954, the most recent year for which full statistics were published, 555 operating plants had a total employment of 7539 persons: 3574 in Ontario, 2094 in Quebec, 685 in Alberta, 534 in British Columbia, 181 in Manitoba, 118 in Saskatchewan and 173 in the Maritimes. Production that year included (in terms of millions of dollars in value): ready mix concrete, 42.7; concrete pipe 11.6; gravel blocks, 20.7; cinder blocks, 3.7; other light-weight aggregate blocks, 2.9; artificial stone, 3.1 concrete bricks 4.2.

Value of materials used totalled $46.8 million; value added by manufacture amounted to $53.34 million. Gross selling value was $102.1 million.

In 1955 employment increased to 8,400, and value of shipments rose to $122.4 million, up 20 per cent over 1954.

CLAY AND PRODUCTS



CLAY PRODUCTS made from Canadian clays during 1956 reached a record value of some $38 million, up nearly 9% above the value of production in 1955, of $34.27 million. Most of the gain was due to the increased production of building brick, though increases were also shown for sewer pipe and in fireclay blocks and shapes. With the addition of production from imported clays of some $17 million, total 1956 production from domestic and imported clays for the year would show total value of some $57 million compared with $48.3 million in 1954.

The industry is divided into two sections for statistical purposes: (1) production from domestic clays, including building brick, structural tile, roofing tile, drain tile, stoneware, sewer pipe, pottery and refractories, and (2) production from imported clays, including manufacture of electrical porcelains, sanitary ware, sewer pipe, table ware, artware, floor and wall tile, and fireclay blocks and shapes. The manufacture of sand-lime bricks and blocks is treated as a separate industry.

The industrial clays of Canada may be classed as common clays, stone-clays, fireclays and china clays. Common clays are produced in all provinces. Stoneware clays are found in Saskatchewan, Manitoba and Nova Scotia. Fireclays are found in Saskatchewan and British Columbia, and to a lesser extent in Nova Scotia. China clay is not produced in Canada but ball clay is produced in Saskatchewan. Bentonite is found in Manitoba and

A reinforced concrete structure houses B.C. Cement Company's new 1,500-h.p. finish mill at Bamberton, B.C. (top).

The largest type of cement kiln used in Canada is the 450-ft. long 12-ft. diameter unit in the Woodstock, Ont., plant of Canada Cement Company Ltd.

Below, the brick plant at Estevan, Sask. A $1.2 million plant at Regina for vitrified clay products is planned by Western Clay Products Limited. (*Photo: Sask. Govt.*)

Alberta. Large quantities of fireclay and china clay are imported.

A total of 161 plants operated in the domestic and imported clay products industries in 1954, the most recent year for which full statistics are available. These plants employed 5973 workers. Combined production was valued at $48.34 million compared with $44.6 million in 1953.

Production in 1954 from Domestic Clays

There were 125 plants in the domestic clay industry in 1954, which employed 3929 persons and produced goods having a gross value of $32 to $36 million. Ontario employed 1887, Quebec employed 867, Alberta employed 382, British Columbia, 244, Nova Scotia 40, with other provinces employing the balance. Materials used were valued at $770,000.

Production of fireclay and firebrick was valued at $231,000; structural tile was valued at $70,000. Production of drain tile, sewer pipe and flue linings was valued at $6.2 million; and pottery at $534,000. Production of bentonite in 1952 was valued at $388,000, while production of fullers' earth amounted to some 16,000 tons in 1953. Exports of clay and clay products in 1954 were valued at $2.2 million.

Production in 1954 from Imported Clays

In 1954 the imported clay products industry had 36 establishments employing 2044 persons, which had a total production valued at just under $16 million. Ontario employed 1126 of these, Quebec employed 733, while Alberta and British Columbia together employed 185. Materials used were valued at $4.1 million.

Products of the imported clay products industry were valued as follows: firebrick and stove linings, $1.29 million; high temperature cements, $291,000; electric porcelains, $4.76 million; pottery, artware, $275,000; sanitary ware, table ware, stoneware; $6.25 million; and all other products, including sewer pipe, floor tile, walltile, flue lining, etc., $3.1 million.

The Sand-Lime Brick Industry

Four plants in Canada operated in this industry during 1954; three in Ontario and one in Quebec. These plants employed 146 persons. Materials used were valued at $515,000. Factory shipments including some building blocks, haydite tile, etc., were valued at $1.93 million. Factory shipments of sand-lime bricks amounted to 38,600 M valued at $1.11 million. Output of sand-lime building blocks were valued at $164,500.

LUMBER

Production of lumber in 1956 in Canada amounted to 7.64 billion board feet, compared with 7.8 billion board feet in 1955, a drop of 2 per cent from production in 1955. In spite of this, the industry enjoyed a good year. The export market was disappointing, however, with exports to the United Kingdom falling 38½ per cent, exports to the United States falling 7 per cent and exports to other countries falling 20 per cent. More than half of the year's production was exported.

Ontario, Quebec and New Brunswick produced somewhat more than in 1955, while Nova Scotia produced somewhat less. Production in the prairie provinces and British Columbia fell slightly. Manufacture of hardwood made a sharp comeback and demand for most grades was steady throughout the year. No general resistance to prices was evident, though resentment was seen growing in the United States market at the increasing exchange premium. Higher ocean freight rates were a dominant factor in price levels in the U.S. and in Europe.

In the domestic market, increasing industrial expansion and the record activity in the construction industry largely made up for the drop in exports. During the second half of the year, however, a sharp drop in housing starts developed in Canada due to the tight money situation.

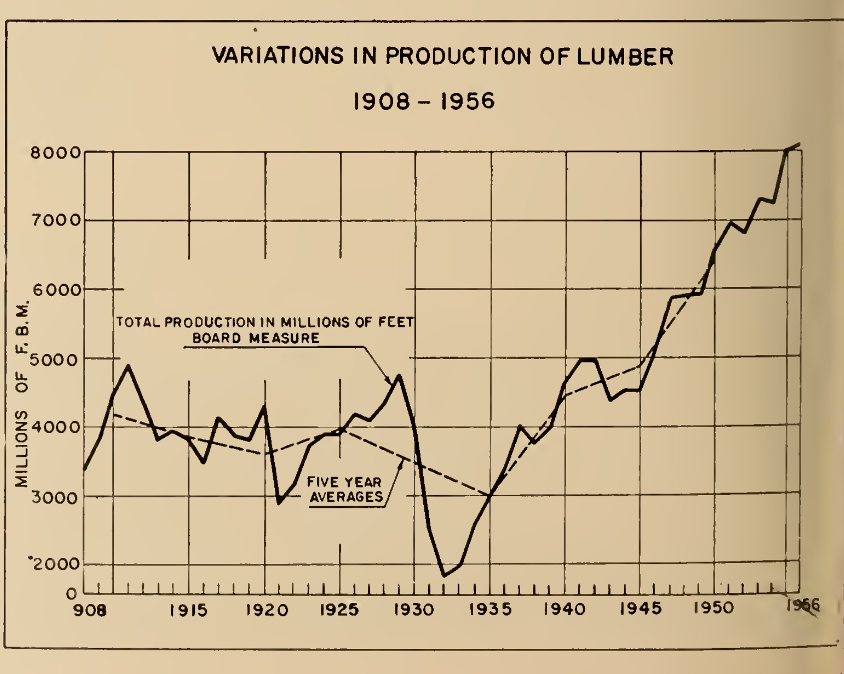
Industry Statistics

To obtain a perspective of Canada's lumber industry as a whole, it is necessary briefly to review operations for 1954, the most recent year for which full statistics are available. In that year, production of sawn lumber amounted to 7.24 billion feet, exceeding the seven billion mark for the second year on record, but down 0.9 per cent from the peak of 7.3 billion feet reached in 1953.

The industry includes not only production of sawn lumber of all dimensions but also that of shingles, box shooks, staves and heading, other saw products, and the barking of pulpwood in plants other than pulpmills. Operations in the woods are not included.

Of the 7696 active sawmills reporting in 1954, 1910 were located in British Columbia, 1721 in Quebec, 1112 in Ontario, 750 in Alberta, 667 in Nova Scotia, 550 in Newfoundland, 388 in New Brunswick, 377 in Saskatchewan, 136 in Manitoba, 68 in the Yukon and N.W.T.

For the year, 1028 small mills were



excluded as well as a few hundred small plants in other groups. Output of these mills accounted for less than one per cent of total production.

The mills range in size from the gigantic mills of the Pacific Coast, cutting up to half a million fbm per shift, to the little mills cutting one to two thousand board feet daily. Larger mills are concentrated around Vancouver, New Westminster, and the lower B.C. mainland, as well as along the Ottawa valley, Georgian Bay, Rainy River and on the coast of New Brunswick.

Employment in 1954 for the industry totalled 57,000 persons of whom 44,500 were production workers; 29,300 were employed in British Columbia mills, 9500 in Quebec, 7500 in Ontario, 2800 in Nova Scotia, 2800 in Alberta, 2500 in New Brunswick and 900 in each of the provinces of Saskatchewan and Newfoundland.

Gross value of all sawmill products produced in 1954 amounted to $572.2 million. Cost of materials and supplies used totalled $301 million, while value added by manufacture amounted to $263.6 million. Exports of lumber during the year totalled some 4 billion feet valued at $326 million, while imports the same year totalled 172 million board feet valued at $19 million.

Production in 1954 was divided between 6.8 billion feet of soft woods and 427 million feet of hardwoods. Of the softwood production 35% was spruce; 29% Douglas fir; 12% hemlock, 6½% cedar and 6% white pine, 4½% jackpine, and 3% balsam fir, with the remaining 3% tamarack, red pine, yellow pine, and cypress.

Of the hardwood production 39% was yellow birch, 25% maple, 12% poplar, 6% basswood, 5% white birch, 4½% each of elm and aspen, with the remaining 4½% beech, oak, ash, alder and cherry.

Principal sawn products in 1954 were divided as follows: lumber 7.2 billion feet valued at $483 million; shingles 2.7 billion feet valued at $24 million; ties 4.7 billion feet valued at $8.1 million; shooks 31 million feet valued at $2.7 million; flatted mine timbers 887,000 valued at $1.8 million; laths 141 million feet valued at $1.5 million; hardwood squares 11.8 million feet valued at $1.4 million; and pickets, staves and heading 33 million feet valued at $1.9 million.

Outlook for the Future

Industry leaders at the Canadian Lumberman's Association Convention early in 1957 pointed to growing signs of resistance to buying both in export and domestic markets, with substitutes out-selling lumber because of price, due to costs of production going up everywhere. Predictions of a 20 per cent drop in housing for 1957, with one dollar being spent on lumber and lumber products out of every six spent on materials for new houses, gave cause for concern. Nevertheless they foresaw production and demand approximately the same in 1957 as for 1956.

Looking further into the future, observers saw the United States market becoming of critical importance to Canadian lumber exporters when the Anglo-European common market, with its 200 million people, becomes a reality. Though the United States can meet its own lumber needs, Canadian exports can still compete and increase if technological improvement and conservation practices limit production costs.

LEATHER

THE ONLY PORTION of the leather products industry of direct interest to the construction and heavy industries is the leather belting industry. Firms classified in this industry are those whose chief item of manufacture is transmission belting of leather. The industry is confined to Quebec and Ontario. Production consists of leather belting, welting, straps, washers and miscellaneous items.

Production in 1954

In 1954, the most recent year for which full statistics are available there were 12 establishments: 6 in Quebec, and 6 in Ontario. Total value of shipments was $1.29 million, 26 per cent lower than in 1953. Of this total production in Quebec was valued at $619,300 and production in Ontario was valued at $667,300. These 12 plants employed 45 persons. Value of materials and supplies used amounted to $513,000, of which 279,300 lb. of belting leather was valued at $382,400. Of the total gross value of shipments amounting to some $1,286,600, production of leather belting was the principal item and was valued at $810,150.

Though statistics for the leather belting industry by ~~itself are not avail~~able for 1955 and 1956, shipments of all leather products in 1955 and 1956 were valued at $225 million and $238 million, 10% and 16% higher respectively, than in 1954.

RUBBER

CANADA'S SUPPLY of synthetic rubber is entirely produced at Sarnia, Ontario by the Polymer Corporation of Canada Ltd., while the nation's supply of natural rubber is all imported. Polymer Corporation, with a total employment of some 1,600 persons, produced some 116 million pounds of synthetic in various forms during 1955, while production in the first 10 months of 1956 was some 17 per cent higher than in the same period of the previous year.

Synthetic production is predominently in the form of Buna-S, followed by Butyl and small quantities of all other types. In addition to a $4 million expansion program now under way, the company will spend a further $7 million on capital projects this year.

The Rubber Products Industry

Canada's rubber products industry in 1955, the last year for which full statistics are available, comprised 82 establishments of which 32 were in Quebec, 42 in Ontario, four in British Columbia, three in Manitoba, and one in Alberta. Ontario accounted for 81% of factory shipments and 70% of the employment, while Quebec accounted for 19% of shipments and 30% of employment.

In 1955, consumption of all types of rubber added up to 223 million pounds: 66% was used in the manufacture of tires and tire repair materials; 2½% in wire and cable; 9.3% in footwear; and 22½% in other products. Production of tires and tubes consumed 45% of natural and 40% synthetic. Wire and cable covering was almost entirely made from synthetic, while footwear was made from 44% of each type.

Canadian industry used more synthetic than natural rubber in 1956, for the first time since the end of World War II. Consumption of synthetic jumped to a record 108.4 million pounds, representing nearly 45% of all rubber used. This compares with 90 million pounds and 40½% of the total in 1955. In 1943, first year for which statistics are available, consumption of synthetic was 8.25 million pounds, jumping the following year to over 55 million pounds.

Consumption of natural rubber in 1956 fell to 96.4 million pounds or 39.8% of all rubber used; from 99.3 million pounds the previous year, 44½% of the total. Top for any year in use of natural rubber was in 1941 with 119.2 million pounds. Consumption of reclaimed rubber in 1956 rose to a record 37.3 million pounds compared with 33.7 million the year before. Stocks of rubber at the end of the year 1956 amounted to 4713 long tons of natural, 6755 tons of synthetic, and 1,589 tons of reclaimed.

CHEMICAL INDUSTRY

THE CHEMICAL industry has expanded steadily since the war years, and the value of production of chemicals and allied materials was estimated, in 1956, to have reached some $1,150-million as compared with (in round figures) $1,050-million in 1955 and $660-million in 1950.

Official statistics for 1956 will only be available after this report is printed, but it is reasonable to accept a figure of about a ten per cent increase in value of total output for 1956 against 1955, or about seven per cent increase in physical volume, allowing for increased selling prices in the later year, which is in line with the average rate of increase in recent years.

The strength of the consumer market and construction activity are reflected in the most apparent increases in the chemical field among primary plastics, pharmaceutical products, and explosives.

Capital outlay for expansion of the industry was announced at the beginning of 1956 to the extent of some $165-million, but some of this proposed work was not completed in the year and will be carried over into 1957, for which no great reduction in the rate of capital expenditure is anticipated. The final figure for 1956 is expected to be at least double that for new investment in 1955 and not much below the 1952 record of $141-million.

Petrochemicals

Probably the outstanding feature of the present general expansion of the chemical industry is associated with petroleum and is noted in the growth of the petrochemical industry. Though not simple to define, this may be said to include the production of chemicals (including plastics) from petroleum or raw materials derived from petroleum (i.e., by-products of oil refineries).

The value of petrochemical production in Canada more than trebled from 1949 to 1955, when it reached about $127-million, and this figure is expected to double again in the next five years.

Sulphur is a particular by-product of the petroleum industry that is becoming increasingly important, and the combined capacity of sulphur plants existing or projected during 1956 will be more than half of current Canadian needs for elemental sulphur, with further capacity in view as sulphur has to be removed from the ever-increasing natural gas supplies.

First item in a new industrial development at Shawinigan East was a sulphuric acid plant, shown below, with a capacity of 25,000 tons per year. *(Shawinigan Chemicals Limited.)*

Other Chemicals

The development of natural resources, particularly the mining and pulp and paper industries, maintains the need for heavy chemicals used in those fields. The extent of the operations is also leading to the construction of chemical plants in areas remote from the existing centres of production, though most of the expansion of the chemical industry continues to be in the industrialized areas of Ontario and Quebec.

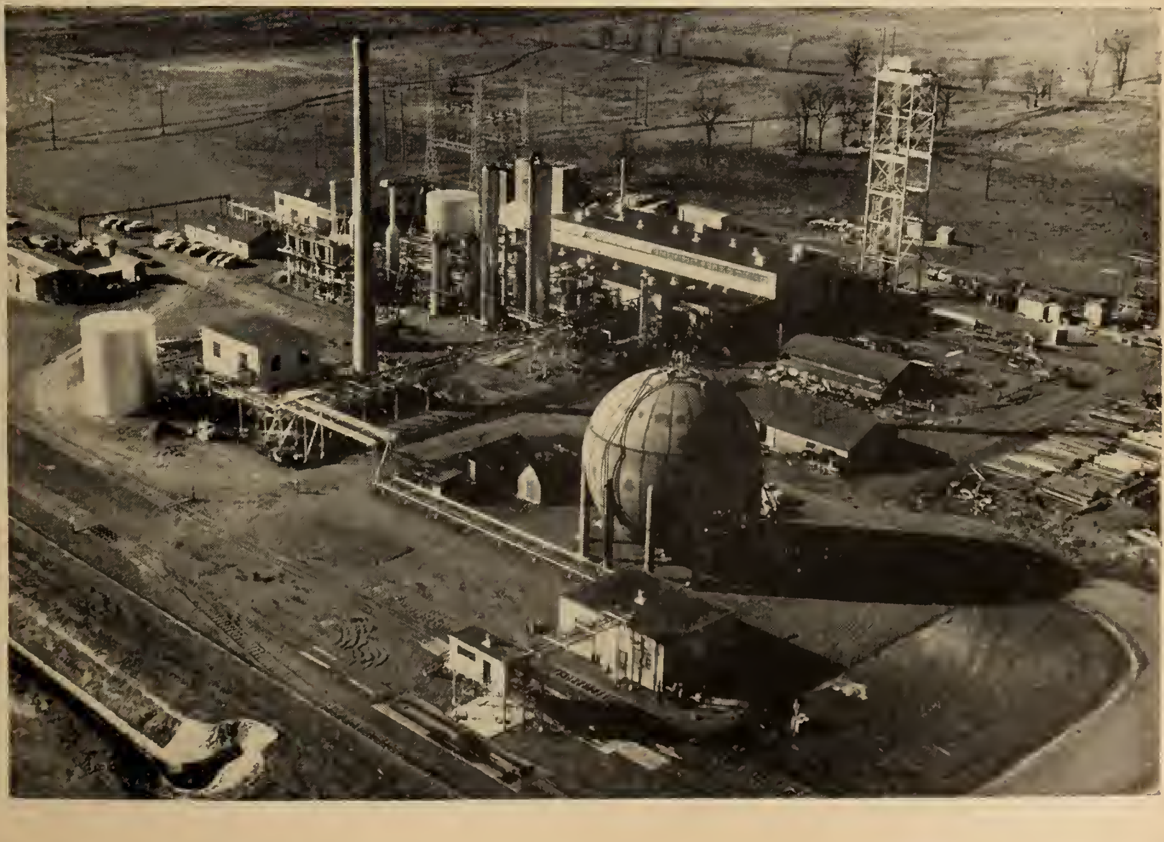
Imports and Exports

Though exports of chemicals in 1956 rose somewhat over 1955, imports from foreign sources increased considerably. Of the total $260.5-million of imports in 1955, over 85 per cent came from the United States and under 9 per cent from the United Kingdom; exports in 1955 showed a sharp increase to $210-million (from $161-million in 1954), of which over 53 per cent went to the United States (more than the pre-war ratio) and less than 10 per cent to the United Kingdom (about half the pre-war proportion of such exports).

Scope of the Industry

For statistical purposes, the chemical industry is considered as a "chemical and allied products" group,

Above, is part of the synthetic rubber plant at Sarnia, Ont., of the government-owned Polymer Corporation Limited, the only indigenous producer of synthetic rubber. Below, a view of the $9,000,000 ammonia plant of Canadian Industries Limited, at Millhaven, Ont., which was brought nearly to completion in 1956.

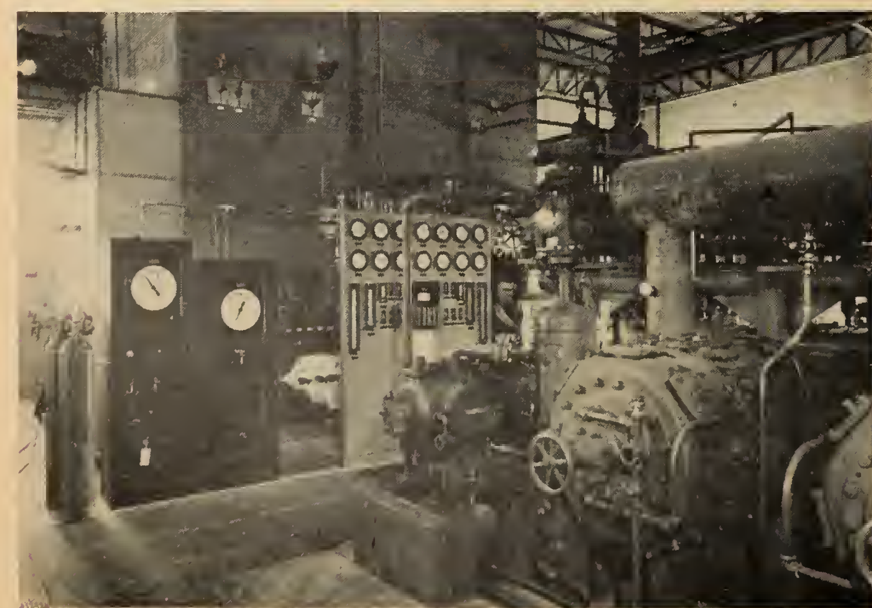


which includes the following main divisions: coal tar distillation; heavy chemicals; compressed gases; fertilizers; medicinals and pharmaceuticals; paints and varnishes; soaps and washing compounds; toilet preparations; inks; vegetable oils; adhesives; polishes and dressings; primary plastics; and a miscellaneous category of such items as explosives, hardwood distillation, insecticides, matches, dry colours, and so on.

In 1955, there were 1112 establishments under this grouping, employing nearly 51,500 persons. The gross selling value of the products of these establishments was nearly $1050-million, for an at-plant cost of materials of almost $482-million and a total cost of fuel and electricity at plant of some $33.3-million. The leading categories, in terms of gross value (in millions of dollars, to the nearest unit) were: the 'miscellaneous' group mentioned above, 218; heavy chemicals, 175; paints and varnishes, 120; medicinals and pharmaceuticals, 105; soaps and washing compounds, 100; fertilizers, 93; and primary plastics, 75.

Extensive construction and development programs call for increasing supplies of explosives. Above is the acid building of a commercial explosives plant near North Bay, Ont., under construction in 1956. *(Photo: Du Pont of Canada.)*

Canadian production of acetylene in 1956 was some 183 million cu. ft. and of oxygen 1,278 m. cu. ft. New plant sites included Moncton, N.B., Sudbury, Ont., Kitimat, B.C., and (an oxygen plant, below) Montreal. *(Photo: Canadian Liquid Air.)*



Expansion in 1956

It is not possible here to record all the details of new plants and extended facilities that were completed, started or projected during 1956, but a few specific examples will serve to indicate how the industry expended its large capital investments.

In Ontario, construction included a new ammonia plant at Millhaven, caustic soda and chlorine extension at Cornwall, sulphuric acid plant at Copper Cliff, hydrogen peroxide plant at Hamilton, and laboratories for paint and plastics research in the Toronto area. At Maitland, Ont., a new plant for acrylic fibre was under construction and bulk storage and filling facilities for hydrogen peroxide were installed. At Kingston, nylon yarn facilities were expanded and new plant started which will produce nylon resin. A new explosives plant at North Bay was nearly completed.

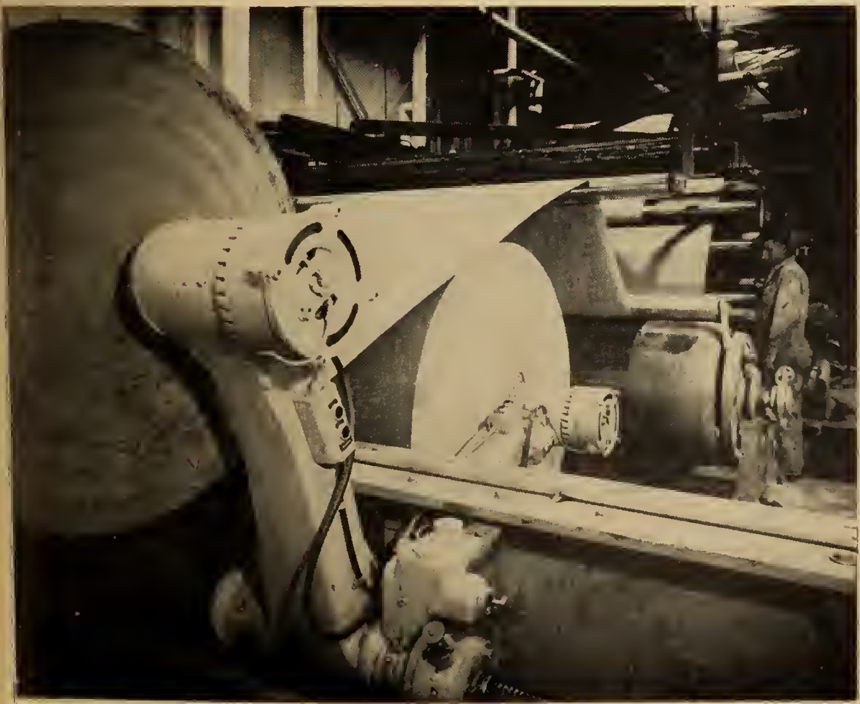
In Quebec, construction included an explosives plant at Sept-Iles; expanded cellulose film facilities at Shawinigan Falls; sulphuric acid, caustic soda, and chlorine at Shawinigan East; vinyl chloride and resins at Shawinigan Falls; phenol, acetone, and hexylene glycol facilities at Montreal East; oxygen and acetylene at Sept-Iles.

In addition to this expansion in existing centres, a new caustic soda and chlorine plant was nearing completion in British Columbia, and the Blind River mining area of Ontario, previously without such industry, will be served by about a quarter of Canada's sulphuric acid capacity.

A government survey in 1956 showed the extent of research in the Canadian chemical industry. This industry spent about $8 million on research during 1955, and planned expenditure proposed at the beginning of 1956 was to be increased by about one-third. Research spending by the chemical and allied groups in 1955 was the third largest.

The giant stackers at the La Tuque mill of Canadian International Paper Company, where a $20-million expansion program was completed during 1956.

PULP AND PAPER



PRODUCTION IN 1956 AND NOTES OF THE MAJOR DEVELOPMENTS IN THE INDUSTRY

The largest corrugator in Canada, installed in the new paper box and converting plant of Crown Zellerbach Canada Limited, at Richmond, near Vancouver, B.C. *(Photo: Jack Cash.)*

THE GREAT forests of Canada have long been one of the country's major assets. On them is based the pulp and paper industry, which is not only one of the largest in terms of manpower and value (it is one of the "billion dollar" industries), but is second in the world only to the United States, regarding the industry as a whole, and considerably the greatest producer of newsprint in the world.

Preliminary figures for 1956 have been published by the industry (final D.B.S. figures are not available until later); these figures show that the gross value of output in 1956 was some $1,400,000,000. This was about $100-million above the 1955 figure of $1.3-billion. Not only was this a record total, but another notable feature was the attainment, for the first time, of a figure for value of exports for the industry in excess of one-billion dollars; this easily kept the industry in its leading foreign-trade position with some 22 per cent of all Canadian exports.

An aerial view of the site of a $38-million pulp mill being constructed near Duncan, B.C., for British Columbia Forest Products Limited. Deep-sea wharf, ferry slip, and scow dock are in centre, rear. Town of Crofton is in the right background.

The individual items that reached new maximum levels of production included pulp, newsprint, paperboard, fine paper, and wrapping paper. The physical output of all products from Canadian mills was about eleven million tons, higher by nearly six per cent than the previous maximum in 1955. The main comparative statistics for production during 1956 and 1955 are shown in Table I.

Pulp

Canadian production of wood pulp in 1956 was 5.7 per cent greater than in 1955. The total figure of some 10.5 million tons compares with the total production in the United States of over 22 million tons, which represented an increase of about 6 per cent over the previous year. Al-

Table I. Principal Statistics for the Pulp and Paper Industry°

	Production 1956	Production 1955	Exports 1956	Exports 1955
Gross value of output	$1.4 billion	$1.3 billion	$1,040 million	$991 million
	tons	tons	tons	tons
Total wood pulp	10,543,016	9,967,641	2,388,484	2,368,420
Dissolving and spec. chem.	411,747	419,899	344,551	358,146
Bleached sulphite paper grades	674,765	637,408	443,530	463,056
Unbleached sulphite	1,834,325	1,738,413	379,893	368,525
Bleached sulphate	812,534	770,155	670,281	652,044
Unbleached Sulphate	801,269	670,229	225,385	214,273
Other chemical	234,022	201,972	45,628	40,917
Groundwood	5,679,983	5,429,162	268,491	259,344
Newsprint	6,468,815	6,190,647	5,971,692	5,805,113
Containerboard	474,227	391,032	56,555	22,608
Boxboard	412,176	397,204	25,274	30,755
Total paperboard	886,403	788,236	81,829	53,363
Fine paper	248,005	215,306	16,712	13,506
Coated paper	29,167	26,198	1,006	1,097
Other printing paper	91,135	79,537	60,684	51,089
Special papers	122,171	113,292	6,437	5,787
Wrapping paper	280,591	257,870	14,309	14,985
Bldg. papers and boards	281,000	262,564	22,500	25,000

There are some slight duplications in the foregoing figures. Some paperboard and wrapping paper is used by the mills for packaging. Coated paper covers a tonnage that undergoes a further processing after it leaves the paper machine and thus is also included under other grades. Total wood pulp production includes screenings, but excludes defibrated and exploded pulp. In addition to wood pulp, the industry uses annually in the manufacture of paper some 570,000 tons of stock including waste paper, straw, rags, cotton linters, flax, leather, jute, and other fibres.

°Provided by the Canadian Pulp and Paper Association. Preliminary 1956 figures.

though consumption rose almost universally, so did the output of the main producers, so that Canadian exports of wood pulp only rose by less than one per cent; there was, however, a substantial increase in domestic consumption of all paper grades of pulp, due to larger production of paper and paperboard by Canadian mills.

Newsprint

The demand for newsprint in 1955 and 1956, particularly from the United States, was such that Canadian mills were regularly operating around two or three per cent above rated capacity. By the end of 1956 increased production rates through plant improvements and the installation of new capacity had overcome the shortage. At the same time, Canadian consumers received 7.4 per cent of output compared with 6.9 per cent of the (smaller) output in 1955. It is anticipated that increased capacity of the industry will allow

Nearly complete in 1956 was the $35-million Hinton, Alta., project of North Western Pulp and Power Corporation (top). A whole townsite and a $5-million natural gas pipeline to bring fuel from the oilfields have been built. Centre, the dark buildings to the rear are new grinder and paper machine rooms added to the Kenora, Ont., mill of The Ontario-Minnesota Pulp and Paper Company, as part of a $20-million construction project. Below, the Elk Falls Company division of Crown Zellerbach Canada Limited at Campbell River, where a $15-million kraft pulp mill was completed in 1956.

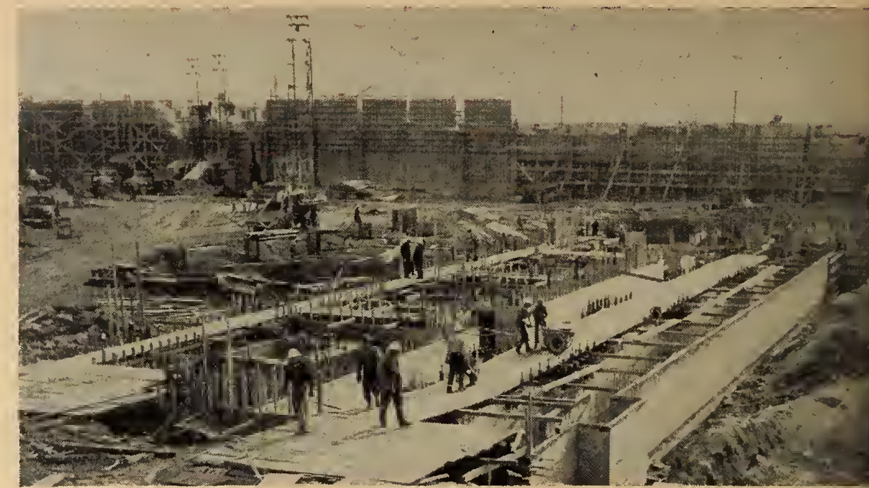
Canadian newsprint mills to operate somewhat below 100 per cent capacity for the immediate future.

Paperboard and Other Papers

Nearly a quarter of the value of the industry's products in 1956, amounting physically to some two-million tons, came from mills making paperboard and papers other than newsprint. Output of nearly all grades was larger than in the previous year, and total exports of paperboard were about 50 per cent greater than in 1955. In Canada, some 1.8 times as much paperboard as newsprint is used, and two-thirds of the paper consumed in Canada is in the industrial categories such as paperboard, wrapping, tissue, and other industrial papers.

Expansion of the Industry

In his report to the 44th annual meeting of the Canadian Pulp and Paper Association, in January 1957, the Association president, R. M. Fowler, compared the position of the industry with that of the whole Canadian economy. Since World War II the value of the pulp and paper industry had risen three-and-a-half times to its 1956 value of $1.4 billion; in the same period, the gross national product of Canada had risen only two-and-a-half times (though this rate of expansion was itself enormous).

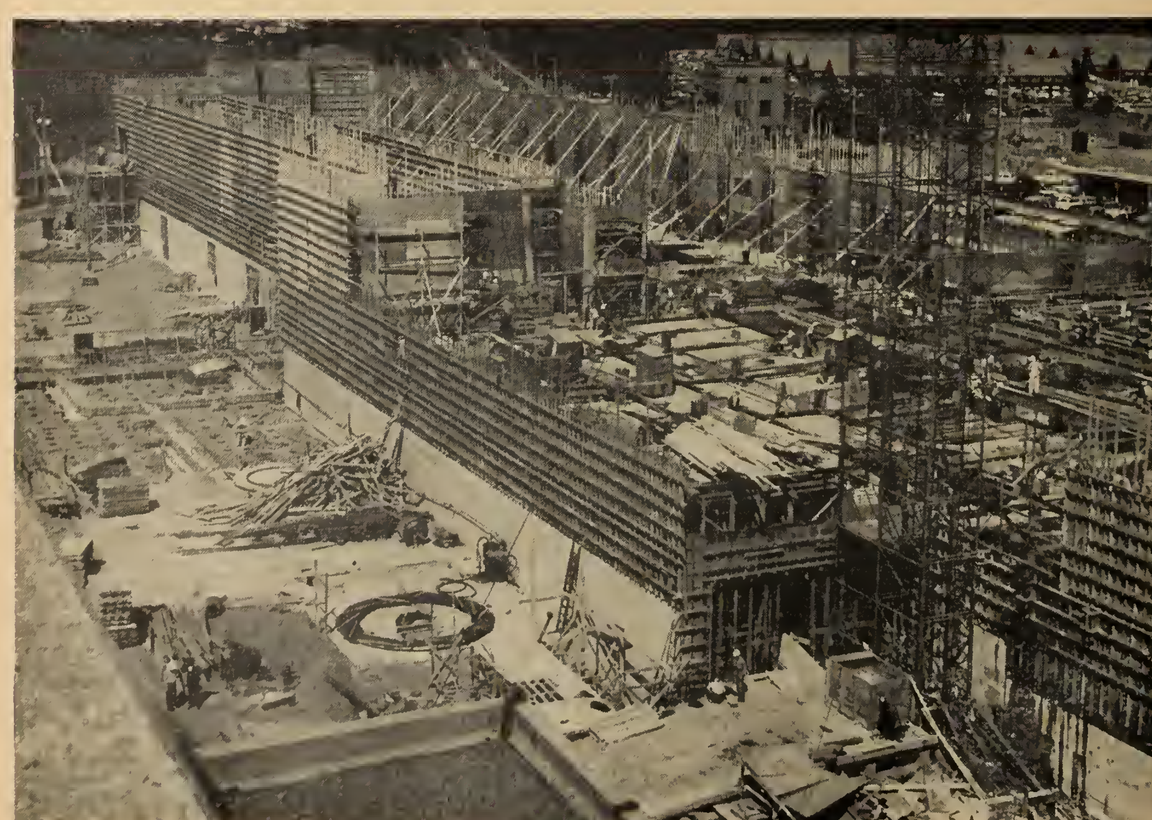


The replacement and modernization of equipment is a continuing process throughout the industry and is of considerable concern to the engineering profession, as are the many entirely new developments that are in hand or projected. It is not possible here to give details of even those projects that were valued at over a million dollars, but a summary will show the magnitude of the operations involved in the expansion of the industry and some of the more important developments are illustrated.

Surveys of the industry* in 1956 showed that in March there were in hand or planned 84 projects for construction and modernization, valued at over $713 million. By June these figures had risen to 101 projects valued at nearly $853 million (less than March by $42 million of the March projects completed and $131 million deferred, but with $312.5 million of new work added).

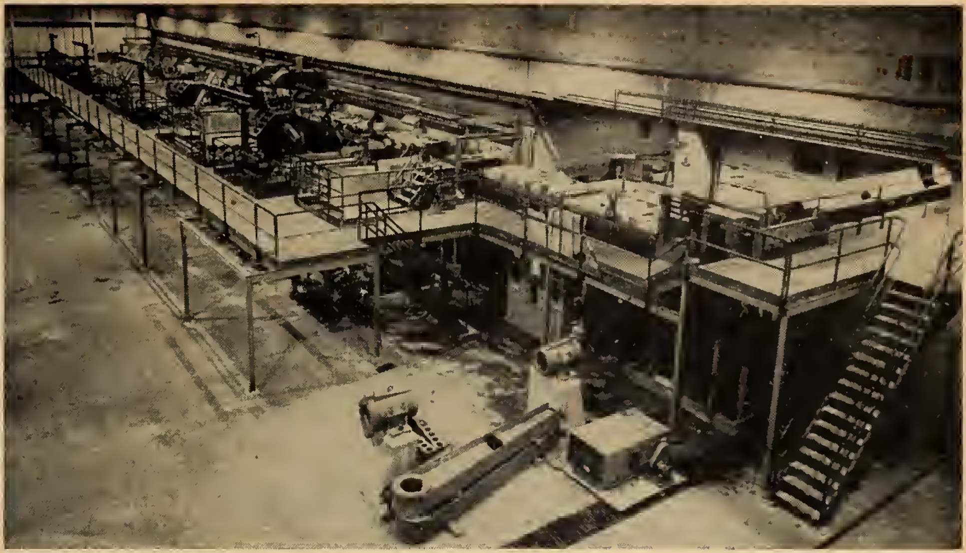
The June survey showed that the industry was developing in areas

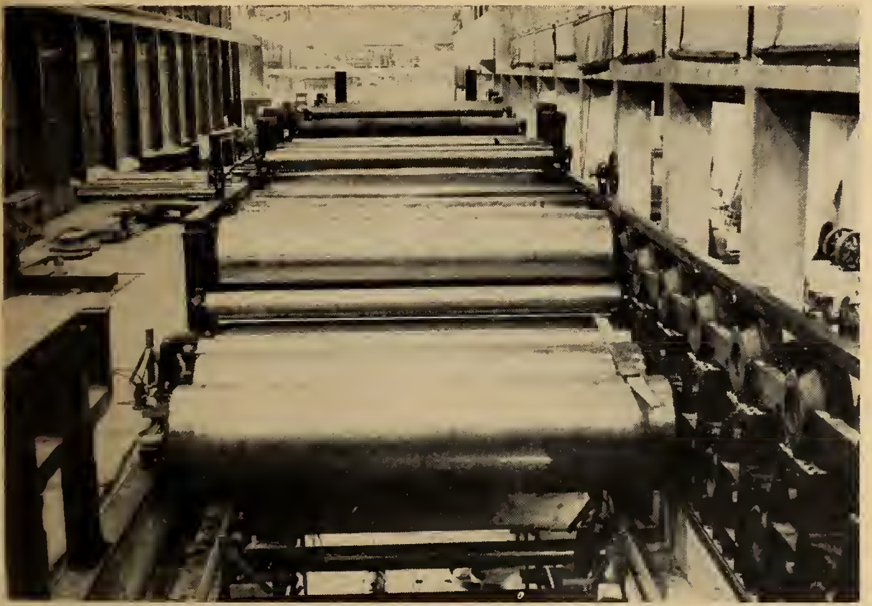
*"Survey of Pulp and Paper Mills in Canada"—*Pulp and Paper Magazine of Canada.*



FROM START

At left (p. 640) is a view of construction during 1956 of Powell River Company's ninth paper machine building (background) and groundwood and screen rooms. In the centre of this page are the dryer section rolls being installed for the No. 9 paper machine.





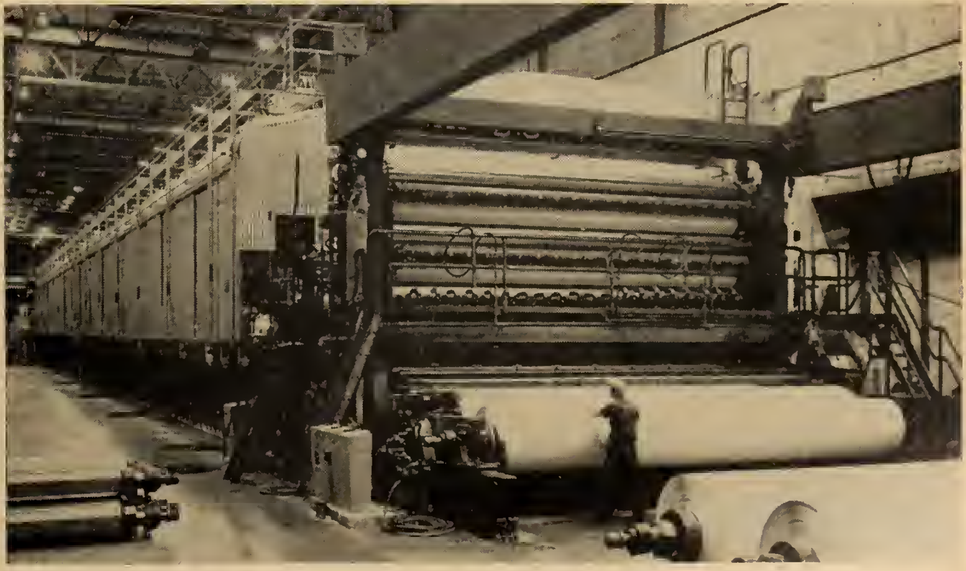
other than the traditional provinces of Quebec, Ontario, and British Columbia, particularly in the prairie provinces. The number of projects listed was divided by provinces as follows: Quebec 33, Ontario 27, British Columbia 17, Newfoundland 8, New Brunswick 4, Nova Scotia 3, Saskatchewan 3, Manitoba 2; Alberta 2; one site was undecided and one company with Canadian headquarters had a project in the U.S.A.

By December, 1956, the carryover of unfinished projects had risen to nearly $945 million. This figure shows the confidence of the industry in the long-term prospects, though there was some slowing of the announced rate of expansion during the year. For example, the cost of new projects announced during the second quarter, already mentioned, was some

TO FINISH

At right is the completed No. 9 paper machine, from the dry end. At the top of this page is an overall view of the new groundwood mill.

At left (p. 640) is a scene of construction at the Port Alberni, B.C., mill of MacMillan and Bloedel Limited, part of a $63-million expansion program. *(Photo: Dominion Construction Company.)*



$312.5 million, whereas the value of such projects announced from July to December was considerably less at $120.2 million.

It would appear that, on the whole, the various fields within the industry are being regarded by those responsible for the progress of the pulp and paper industry in Canada with an eye to keeping abreast of demands for products, or even a little behind the immediate demand, rather than to provide capacities that could become excessive by an uneconomical margin within the reasonably near future.

Power Developments

The establishment of a producing centre of the pulp and paper industry in any particular area depends on the availability of sufficient quantities of power. For this reason, the industry frequently sites its plants within reach of the large hydro-electric developments and several companies have their own extensive interests in power production.

One of the outstanding developments under way during 1956 was the Hinton, Alta., project of North Western Pulp and Power Company. This is not only a major undertaking, and the largest of its kind so far in Alberta, but is claimed to be the first mill in the world to use natural gas as fuel for all operations. To supply this fuel a $5-million pipeline has been built from the Alexandria oil-fields near Wabamun.

In the more conventional field of hydro-electric power production, a few examples will indicate the relation between the two industries.

Part of the Ontario Paper Company operations during 1956 was the start of construction on the McCormick dam project No. 2, on the Manicouagan River. This will eventually add 150,000 h.p. to the existing 100,000 h.p. capacity of the generating station. The project is in an area, also being further developed by Hydro-Quebec, that will supply aluminum developments at Baie Comeau and requirements of the Gaspe Peninsula.

Work was also started on the Murdock-Wilson power development on the Shipshaw River, which will bring in a new powerhouse to supply mills of Price Brothers and Company who operate nine power plants.

The expansion program of the Powell River Company (illustrated in this report) involved the provision of additional facilities from B.C. Electric Company, including a 107-mile transmission line that crosses Jervi Inlet; this aerial crossing, at 10,10 ft., is the fourth longest in the world

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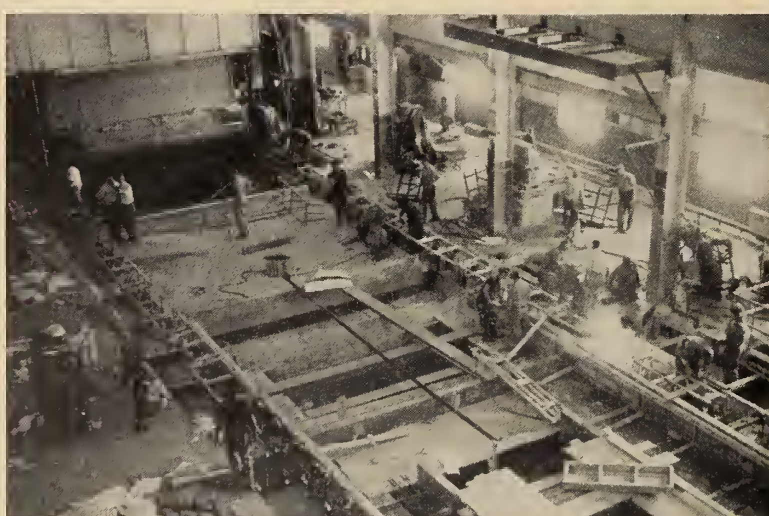


Top, a general view of the expande mill of the Dryden Paper Company, Lin ited, at Dryden, Ont. Over $11-millio will be spent on increasing capacit Centre, installing new base plates i fourdrinier and press section durin rebuilding of newsprint machines at th Pine Falls, Man., mill of Manitoba Pap Company, division of Abitibi Power Paper Company. Bottom, view of con struction of a bleached sulphate mill fo the Thurso Pulp and Paper Compan part of a $16-million project.

Representing the armed services are the destroyer escort HMCS *Ottawa*, a line-up of Mark 6 Sabres of the RCAF, and a demonstration of the Army's new FN (C1) rifle. (*National Defence Photos.*)

NATIONAL DEFENCE AND DEFENCE CONSTRUCTION

)ver $20-million was ex-)ended on construction of he Army's Camp Gage-own, right, during 1956. At ight of the foreground is he central heating plant, ne of the most advanced in anada At left foreground the ready-mix concrete lant serving all contractors orking in the camp.

The new light fleet aircraft carrier HMCS *Bonaventure* carried out her first sea trials at the end of 1956 from the Belfast yard of Harland and Wolff, Ltd. Propelling machinery includes four Admiralty three-drum boilers and single reduction steam turbines.

NATIONAL DEFENCE

A FULL REPORT on the National Defence Program for the fiscal year 1956-57 will not be published until May 1957. Thus it is only possible to quote the Department's intentions for the year as outlined in the Annual Estimates approved a year ago by Parliament, and to add thereto comments from the three armed services, from Defence Research and from Defence Construction (1951) Ltd. as to what extent these intentions were carried out.

In the main, production of equipment for the services, with exception of imported equipment and construction of barracks, air fields, and other facilities, is included in production figures contained elsewhere in this special review issue from various industries, such as those concerned with steel production and processing electrical manufacturing, shipbuilding, aircraft production, motor vehicle production, and construction.

In practice, each service prepares its estimates, gets them approved by Parliament and does much of its own engineering and design. Purchases of supplies and equipment are made through Defence Production, while contracts for construction and for engineering supervision thereof are awarded by Defence Construction (1951) Ltd.

Defence Estimates for 1956-57

National Defence Estimates for the fiscal year 1956-57 totalled $1,775 million, the same as for the previous year, of which only $1,750 million had been actually spent as of March 31, 1956. This total of $1,775 million was divided as follows, in round figures: military personnel costs, $480 million; operations and maintenance, $570 million; procurement of equipment, $533 million; construction, $146 million; NATO and Infrastructure budgets, $18 million; mid - Canada Line, $100 million. Deductions for charges to special accounts amounting to $72 million reduced the total to the amount of the official Estimates.

The total was earmarked for the various services and for other purposes as follows: navy, $325 million; army, $477 million; air, $872 million, defence research, $79 million; mutual aid, Infrastructure and NATO budgets, $143 million; and administration and pensions, etc., $68 million. Deductions due to credits for mutual charges to special accounts of $189 million reduced the total to the amount of the official estimates.

Military and Civilian Personnel

Strength of the regular forces at the end of 1955 including cadets and apprentices stood as follows: navy, 19,223; army, 47,162; air force, 50,330; a total of 116,715. Total strength of reserve forces stood at 56,490. Added thereto were civilian employees in the three services and the Defence Research Board, and for inspection and administration, numbering 54,500, and at National Defence Headquarters a further 4330 civilian employees. Officer candidates in training at Canadian service colleges, at universities, and under other plans as of the same date totalled 6,947. Militia personnel attending training courses at summer camps totalled 20,568 (all ranks).

Military personnel costs totalling $480 million in 1956-57 estimates were divided as follows: navy, $80 million; army, $198 million; and air force $202 million. Principal items under this heading are pay and allowances, travelling and removal expenses, clothing and food.

Operations and Maintenance

Estimates for 156-57 totalling $570 million for operations and maintenance included major classes of expenditures for the three services totalling $478.7 million, divided as follows: navy, $95 million; army, $127.2 million; and air force $256.5 million. By categories they included: civilian employment $148.3 million; communications, printing and advertising $11.6 million; barracks and stores, $51 million; gas and oil, $41.8 million; equipment, repairs and spare parts, $155.3 million; property and building maintenance including rentals and utilities $155.3 million; and miscellaneous $62.4 million.

Equipment Estimates

Excluding the Mid-Canada Line, total provision for equipment in the 1956-57 estimates was set at $138.7 million for the navy; $78.8 million for the army; and $256.9 million for the air force. Equipment purchases were forecast as follows: aircraft and engines, $229.7 million; ammunition $70.2 million; ships, $60 million; electronics, $44.8 million; armament $29 million; vehicles, $23.5 million; tanks and A.F.V.'s, $0.6 million; miscellaneous technical equipment, $15.2 million; special training equipment, $8.9 million; and other items, $50.6 million.

Continuing production at reduced rates was provided for CF-100 and F-86 aircraft. Production of Wasp aero engines for mutual aid would be completed in 1956. Deliveries for the CL-28 long range maritime reconnaissance aircraft were to be commenced and pre-production models and production tooling costs for the CF-105 were provided for.

Production of the ammunition program was reduced and revised to maintain production at reduced rates over a longer period of time. Production of the new type small-arms ammunition for the army was to be started. The RCAF estimate provid ed for procurement of test-vehicles for air-to-air missiles.

No new major ship construction programs were planned for 1956-57. Estimates for construction of HMCS *Bonaventure* were the same as for the previous year, and those for anti-sub escorts, minesweepers and modernization of frigates were less than for the previous year.

The estimate for electronics equipment, excluding that to be procured for the mid-Canada line, was $2 million below that for 1955-56. Provision was made for improvement and standardization in the power supplies and navigational equipment aboard naval vessels and in electrical and electronic equipment of naval aircraft. Procurement of new types of wireless equipment for the army was provided for.

For the army, there was increased provision of production of the FN-CI rifle, and for procurement of special military pattern vehicles of ¾-ton, 2½-ton and 5-ton capacities. Final payments on existing contracts for tanks and armoured vehicles were also included. Substantial production of two new types of navigational aids developed by the RCAF for installation in aircraft were provided for.

Defence Research

The appropriation for defence research during 1956-57 of $79 million was 50 per cent higher than for the previous year. This reflected both the challenging nature of the rapid evolution of military equipment needed by the fighting services and the growing ability of Canadian scientific and engineering team to provide vital assistance to the armed forces.

The 1956-57 estimates included provision of $23.1 million for operation of the Board's 11 research laboratories across Canada, as well as for grants and contracts with Canadian universities. The balance of the appropriation covered development programs of the three services. The principal increase of some $23 million was directly related to anticipated expenditures in connection with the CF-105 project and the guided missile program.

Also included therein was provision for research on geophysics and meteorology, oceanography, etc., in the far north; electronics and telecommunications, military medicine; environmental protection; materials; aeronautics; civil defence; evaluation of weapons systems; guided missiles.

Construction

Provision in the estimates for construction was divided as follows: for the navy, $11.2 million; for the army, $72.7 million; and for air, $56.9 million. A breakdown by types of construction showed: station development barracks, hangars, supply depots, workshops, etc., $93.9 million; married quarters and schools, $26.6 million; airdrome development, $6.5 million; minor construction projects, $9.2 million; and purchase of property $4.6 million.

Purchase of Equipment (Air Force)

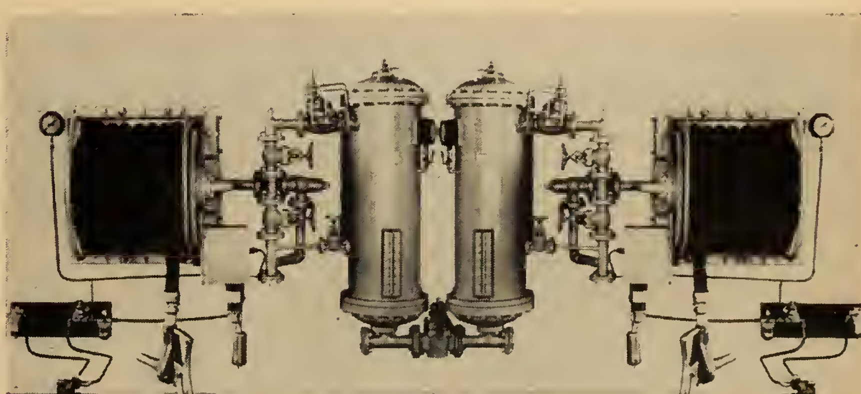
Though 1956-57 estimates for air force equipment remained at $872 million, the same as for the previous year, the current trend was indicated by the drop in appropriations for new aircraft and engines to $197 million from $293 million in 1955-56. Among the major items in the 1956 production were included the following:

(1) Mock-up and tooling for the supersonic delta-wing CF-105.

(2) Continuation of production of the CF-100 Mark V on a limited basis, with one squadron equipped for service in Germany during the year and two more to follow in 1957.

(3) Successful completion and flight test of the new 'Iroquois' engine by Orenda Engines Ltd., with production of 'Orenda' engines continuing at a low rate.

The aviation fuelling system for HMCS *Bonaventure* has 28 fuelling points on flight and hangar decks; each point can filter 150 g.p.m. of fuel (a hangar deck unit is shown below). A duplicate system can blend gasoline and kerosene in the range of ratios 1:1 to 1:5 at 300 g.p.m. Lower picture shows a reduction gear casing cast in aluminum alloy; light alloys are widely used in Naval vessels.



The illustrations on pp. 643-648 are from National Defence photographs.

(4) Preparation at Bristol Aircraft (Western) Ltd., for producing a large number of anti-submarine helicopters for the navy.

(5) Conversion of 50 CF-100 Mark 3's to two-place CF-100 trainers and conversion of a number of B-25's to light bombers, both for the RCAF.

(6) Commencement of the new overhaul repair project on C45's and other aircraft.

(7) Completion of the first CL-28 maritime reconnaissance aircraft, first of an order for 25. An order for the military transport version, the CL-44, is expected for 1957 production.

(8) Production of Wasp R-1340 and Wright R-1820 engines for the navy's CS2F-1 program.

(9) Commencement of production on an order for 60 Grumman CS2F-1 aircraft with spares for another hundred for the navy.

(10) Production of DHC-3 'Otters' and DHC-1 'Chipmunk' basic trainers.

(11) Completion of an RCAF order for 'Nene-10' engines for T-33 trainers, and overhaul of J-33 jet engines for new 'Banshees' for the navy.

Purchase of Equipment (Navy)

The largest number of war vessels ever completed in a peace-time year were commissioned in 1956. HMCS *Assiniboine*, the first entirely Canadian-built destroyer escort, was commissioned for service in August. Two more destroyer escorts, HMCS *Saguenay* and HMCS *Ottawa* were also completed. HMCS *Gaspe* and HMCS *Cowichan*, the first two of fourteen 390-ton MCB class minesweepers, were launched in November, while another, HMCS *Fundy* was under construction.

HMCS *Bonaventure* a new light fleet aircraft carrier, carried out her first, sea trials at Belfast towards the end of the year. HMCS *Bluethroat*, a new mine layer and loop layer, entered the service during the year. Launching of the 840-ton ocean-going naval tug, the *Saint John*, took place in May. This is one of three such vessels under construction for the navy. Other completions during year included three PCS vessels, HMCS *Cormorant*, *Blue Heron*, and *Mallard*, one YMT-10 clearance diving vessel and one YSF ammunition lighter.

The first of the navy's jet-fighter squadrons VF 870 was equipped in 1956 with McDonnell F2H-3 Banshee aircraft purchased late in 1955 from the US Navy. Addition of these fighters made necessary the establishment of new jet overhaul facilities at Dartmouth. The navy also took delivery last year of the first of its new anti-submarine aircraft the CS2F-1 tracker, one of an order for 100 such aircraft, a Canadianized version of the Grumman S2F-1 Sentinel.

During the year the search was continued for new techniques for meeting electrical power requirements with equipment of improved performance, compactness and durability. Trials were carried out on ship-prewetting systems for keeping ships wet in order to wash away radioactive particles. Applications of glass-reinforced plastic were tested for small boat construction.

The Army's new field telephone set TA-43/PT was designed for efficient operation under rigorous conditions. It weighs 9½ lb. and range of operation is 14 miles under wet conditions, 22 miles in dry conditions.

Another new Army means of communication is the field radio set AN/PRC-510, a portable, continuously tunable FM unit with a working range of about five miles in the 58.0-54.9 Mc. frequency range. The set is immersion-proof and is designed to withstand dropping by parachute.

Purchase of Equipment (Army)

There was no new armament procurement nor any new production program set up in 1956-57 estimates with significant impact on the 1956 program, with exception of $2 million to be spent on new types of wireless equipment and increased provision for production of the FN-C1 rifle. Completion of the 1955/56 contracts for 2½-ton and 5-ton vehicles was provided for at a lower rate than in 1955. Provision in estimates for tanks and armoured fighting vehicles was for final payments on existing contracts for which deliveries had been completed the previous year.

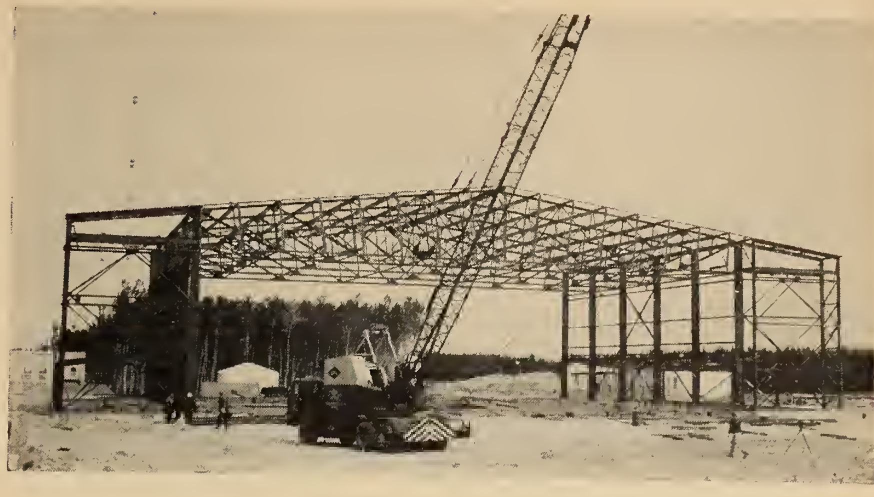
Expenditures in 1956 included (approximately): $45,000 on a 3.2-in rocket launcher, and $1.4 million on 3.2 rockets; $1.65 million on the FN (C1) rifle; $495,000 on a new field radio set (AN/PRC-510); and $400,000 on the new TA-43/PT field telephone set.

DEFENCE CONSTRUCTION

The government agency responsible for the construction aspects of the defence programme is Defence Construction (1951) Limited, known as D.C.L. When requested by National Defence to erect a building and supplied with necessary funds, it is the responsibility of D.C.L. to call tenders, award contracts, supervise construction work, make payments, and turn over the completed building to the service involved. When required D.C.L. engages engineers and architects on a consultant basis for the design of buildings and facilities and for various engineering services. In the six years of its existence D.C.L. has processed $950 million worth of defence construction contracts. In this period expenditures were averaging $140 million a year.

In addition to the defence construction program which is the prime responsibility of D.C.L., this agency has a part in two non-defence projects. In connection with the construction aspects of the Colombo Plan, D.C.L. has been assisting the International Economics and Technical Co-operation Division of the Department of Trade and Commerce and the Canadian Commercial Corporation. D.C.L. is also advising and assisting the Northern Ontario Pipe Line Crown Company on the construction aspects of the Northern Section of the Trans-Canada pipe lines.

1956 was a busy year for D.C.L. Payments made for work performed under D.C.L. contract exceeded $160 million, compared with $104 million in 1955 and $97 million in 1954. More han half of the total was spent on RCAF projects, with the Army construction projects second, the Navy program third and the Defence Research Board program fourth in dollar volume. The two outstanding projects, as in the previous year, were he Mid-Canada Line and the Gagetown camp. It can be expected that vith these two very large projects in heir completion stage the total volume



t top, a permanent hangar being built t Cranberry Portage, northern Manioba, on the Mid-Canada Line, of which n operations building and antenna ower are shown, centre; the tower is me 350-ft. high. The bottom picture hows the CL-28 *Argus*, in production Canada for the RCAF Maritime Command. (See also "Aircraft", p. 628).

of construction work in 1957 will be reduced approximately to the level of 1954 and 1955.

Projects for RCAF

A large proportion of RCAF expenditures on construction in 1956 was for work contributing to the common air defence system of Canada and the United States. The jointly operated system for warning of the approach of enemy aircraft and for the control of interceptor aircraft consists of four main elements. The first chain of radar installations, known as the Pine Tree Line, runs through the populated part of Canada, was jointly built and is jointly operated by Canada and the United States. The second element of the defence system is the Mid - Canada radar warning line, built and operated by Canada. The northernmost Distant Early Warning Line (DEW Line), built and operated by the United States, is the third element. The fourth element added to the system by the United States is formed by radar stations covering the seaward approaches on both flanks of the continent.

D.C.L. has been taking a part in all of these projects except the DEW Line. The work carried out in 1956 was in connection with the Mid-Canada Line (the largest RCAF project currently under construction), and three additional stations for the Pine Tree Line. The last of these projects was administered by D.C.L. on behalf of the United States government.

Other RCAF projects under construction in 1956 included continuing work on RCAF bases in Canada and in France where two Canadian Fighter Wings and the Air Division Headquarters are stationed. These units together with two other Fighter Wings stationed in Germany constitute the Canadian contribution to the NATO air forces in Europe.

Projects for the Army

The most important Army project under construction in 1956 was Camp Gagetown in New Brunswick where last year $20.5 million worth of work was put in place.

At present Camp Gagetown presents a very different picture from what it was at the beginning of the project three years ago. In an area which was completely wooded, there is now quite a large built-up area complete with all services such as roads, water, sewer, light and power. At the end of last summer's work there had been completed 17½ miles of paved streets as well as the paved vehicle compounds and two large parade squares with an area of approximately ten acres each.

In all, 102 buildings have been built or are under construction, 24 of these are now in use by the Army and most of the remaining buildings are over 90% complete. The buildings are all centrally heated from one of the most up-to-date hot water plants and distribution systems on the continent. The main lines of the distribution system run in underground tunnels of which there are about 5 miles. In addition to the heat distribution these tunnels also carry such services as water, light, and communication lines. The work of landscaping or ground improvement is scheduled for this coming summer and the cost of this is estimated at three-quarters of a million dollars.

Camp Gagetown is the largest establishment planned under the Home Station development program. Most of the remaining large Army projects now under construction are also part of the program. The second largest camp of this type is being built at Petawawa, Ontario. In 1956 construction work continued in all three areas. The largest expenditures, as in previous years, were for work in the Halifax area.

The largest Defence Research Board project under construction in 1956 was the Suffield Experimental Station in Alberta. This 100-square mile establishment, the largest of the Defence Research Board stations is engaged in experimental and trials' activities related to the defensive aspects of biological, chemical, and radiological warfare. The main building, the largest modern laboratory in Western Canada, was completed in 1955. In 1956 work continued on smaller buildings, roads, and other facilities.

The very high level of construction activity in 1956 has placed a strain on the available supply of skilled labour and certain key materials especially structural steel. D.C.L. in an effort to avoid long delays in steel deliveries, has reverted to a practice used in 1952 and 1953 when steel was in short supply. As soon as plans are sufficiently advanced to allow ordering of structural and reinforcing steel, tenders are called for these materials separately and well in advance of the tender call for the erection of the building, so that steel may be available on the job when required. In addition to avoiding some delays this practice reduces the contractors' costs of financing the job.

The problems of winter unemployment, the hardships and wastes created by it have been receiving more attention and publicity in the past two years than ever before. For D.C.L. to have permitted winter shutdowns on construction sites would have meant delays in completion of urgently required defence facilities. Therefore it has always been the policy of D.C.L. to insist that work be continued throughout the winter months whenever practicable.

This requirement is embodied in a clause in all D.C.L. contracts. The degree of success achieved is indicated by the fact that 45% of all construction work carried out is being put in place each year in the six months between November and April. This policy, apart from securing the earliest possible completion of a project, is also contributing towards development and general acceptance of methods making winter construction work possible.

A load of fuel and equipment being hauled to a site on the Mid-Canada Line.

Work for the National Harbours Board in 1956 included this concrete crib wharf and sewer outfall in Montreal.

AGRICULTURE

FORESTRY

FISHERIES

GOVERNMENT AND MUNICIPAL WORKS

CONSTRUCTION

HOSPITALS

SCHOOLS

WATER AND SEWAGE

HIGHWAYS

An aerial view of Pier A-1, Halifax, another work for the National Harbours Board. *(Photos: Foundation Company of Canada.)*

STATISTICAL REPORTS of government services at all three levels, federal, provincial, and municipal, are not compiled as such by the Dominion Bureau of Statistics. Complete annual government reports are not published until about a year or more after the end of each fiscal year. For an up-to-date review of the work undertaken in 1956 it is thus only possible to piece together information gathered from several sources.* From these sources a somewhat indefinite picture of government construction, excluding defence, may be developed.

Apart from the many and diverse services performed by federal, provincial, and municipal governments such as regulation, supervision, research, police and fire protection, rentals, finance, justice, public health and welfare, wild life protection, veterans affairs, national defence, postal services, and many others, which cannot be valued in dollars, the end product is in the form of buildings, highways, canals, airports and public works. The dollar volume of production of these, value of materials used and the number of employed are included in the DBS reports of the construction industry; or under defence construction, railways, transit, civil aviation, and other industries reviewed elsewhere in this issue.

Government Construction About 15% Of Total

In the fall of 1955, the annual survey of proposed capital investment conducted by the Department of Trade and Commerce for 1956 disclosed intentions by governments at all levels for buildings and public works amounting to $1,155 million, or roughly 16 per cent of the total 1956 construction volume for Canada. Of this, $330 million was proposed by the Federal government, $510 million by the ten provinces and $315 by municipalities, including cities.

Building construction alone, totalling $317 million, was divided as follows: federal, $210 million; provincial, $60 million; and municipal, $47 million. Government office buildings totalling $100 million and institutional buildings at $65 million, most of them proposed by federal and provincial agencies, were main items.

Public Works at $838 million were divided thus: federal, $120 million; provincial, $450 million; and municipal, $268 million. Of the total, largest outlay proposed was for highways, bridges, tunnels, and subways at $26 million by the federal government, $428 million by the ten provinces, and $119 million by municipalities.

Division of Work by Regions

For a breakdown of these government intentions as between regions we must examine the figures on 'Contract Awards' for 1956 as published in the MacLean *Builder's Guide.* These award figures are generally found to cover between 60 and 90 per cent of actual construction accomplished, depending on the type of contract, category of work and the region where it is done. For Maritime and Western provinces coverage is generally less complete than for central Canada.

Contract awards for government building construction in 1956 showed 39% of the total value was for Ontario; 30% for Quebec; 17% for the prairie provinces; 8% for British Columbia and 6% for the Maritimes. Awards for public works showed 35% for Ontario, 27% for Quebec, 15% for the Prairie provinces, 16% for British Columbia, and 7% for the Maritimes.

Forecast of Institutional Building

In its annual review issue, at the end of 1955, the *Daily Commercial News* reviewed the work under way or proposed for 1956 on government buildings, schools, hospitals, and water and sewage projects. Not all of the schools and hospitals were necessarily government projects, some of them being financed by religious orders, by universities, colleges, school boards or private individuals or groups.

Government buildings were summarized as follows: five in Quebec valued at $26 million; six in Ontario costing $16 million; six in the prairie provinces costing $26 million; and two in British Columbia costing $11 million; a total of $79 million.

Hospitals were listed at nine projects in the Maritimes costing $6 million; twenty-four in Quebec costing $82 million; fifty-nine in Ontario at a cost of $70 million; eleven in the prairie provinces costing $8.4 million; and six in British Columbia costing $19 million; a total of $185 million.

Proposed construction of schools included ten projects in the maritimes at a cost of $3½ million; forty-four in Quebec costing $40.7 million; ninety-three in Ontario costing $90 million; fifteen on the prairies costing $5 million; and two in British Columbia costing $2 million; a total of $141 million.

Water and sewage projects, which are predominantly municipal responsibilities, were forecast at a cost of $113 million for Ontario alone for 1956. For all Canada no comparable financial estimates are available, but recent figures showed the number of municipal sewage treatment plants to be about 520, of which 309 were primary treatment. Sewered municipalities in Canada totalled 845 and serviced about 55 per cent of the Canadian population. When this percentage is compared with nearly 1600 municipal waterworks systems, serving some 65% of the population, it is obvious that many more sewers and treatment works are required for Canada's growing communities.

Preliminary Estimates of Work Done

Preliminary Department of Trade and Commerce estimates of actual work accomplished in 1956 showed a value of some $200 million for schools, compared with $189 million for the previous year. Expenditures in 1956 for hospitals were estimated at some $132 million for construction and $19 million for equipment, as compared with $146.6 million the previous year. In both categories the volume is expected to be higher for 1957. The outlay for government public buildings on the other hand, is expected to be less in 1957, with a larger number of smaller buildings projected. Various governments are expected to spend some $770 million during 1957 on highways and structures.

Provincial Public Works

Typical of the work carried out by the public works departments in the ten Canadian provinces is that of the Ontario Department of Public Works, which has a large construction program under way and planned to meet the requirements of the several departments of the government in carrying out their programs of public services to citizens of the province.

This program consists of new buildings for educational purposes, mental health, administrative offices, provincial police buildings, reformatory institutions, court houses, registry of-

* Department of Trade and Commerce, annual survey of capital investment; Federal Department of Public Works, annual reports; MacLean's *Builder's Guide;* and *Daily Commercial News.*

fices, divisional buildings for the Department of Highways and service buildings for the Department of Lands and Forests.

The Department also builds storage dams in the northern part of the Province and assists various municipalities in connection with drainage problems.

Largest Construction Volume

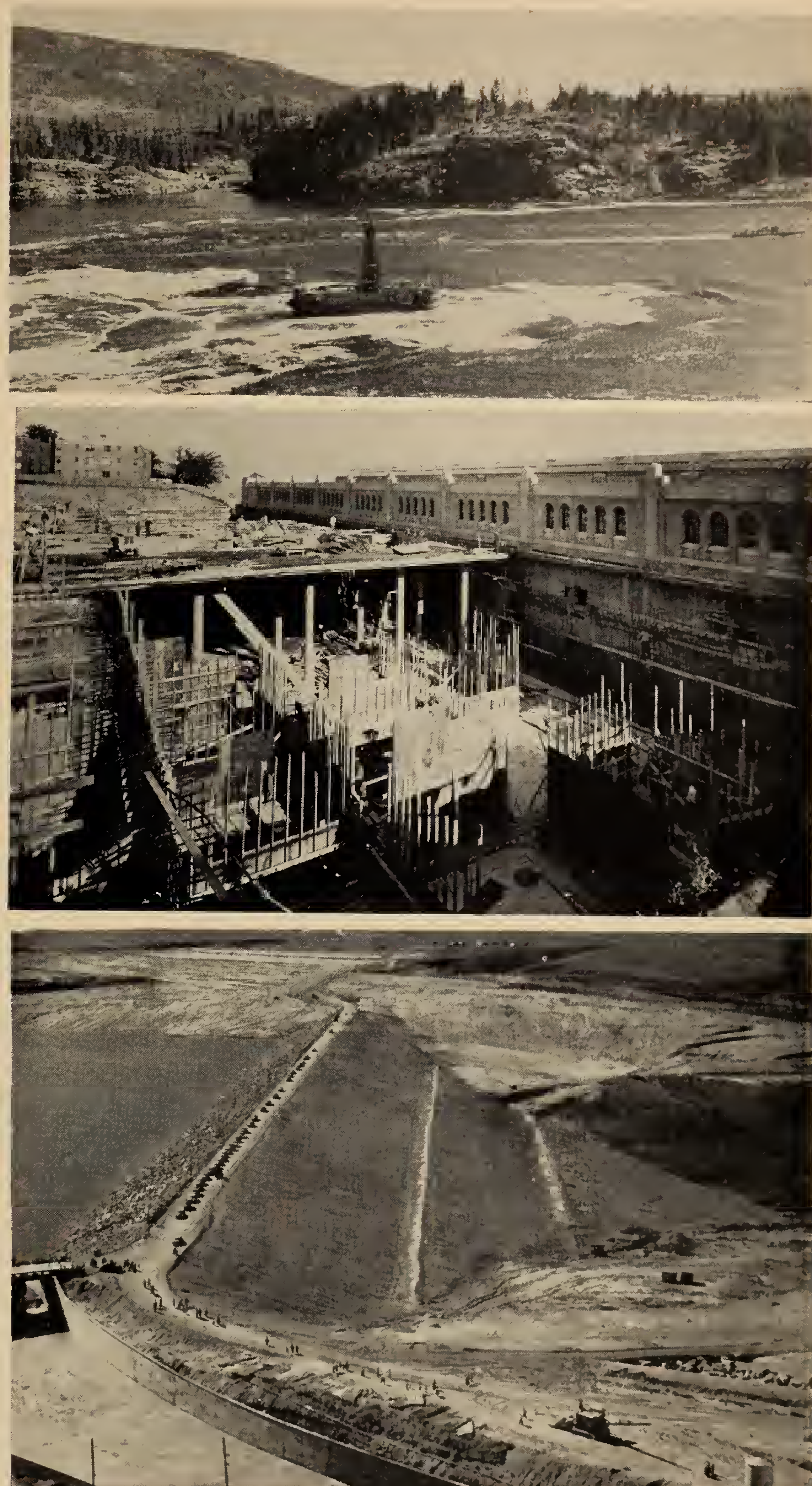
During 1956 the largest volume of construction in the history of the Department was carried out and this effort will be at least equalled or surpassed during 1957. One of the largest sections of construction work was to provide bed accommodation with other ancillary facilities for the Ontario mental hospitals.

During 1956 additions to mental hospitals at Hamilton, Kingston, and Toronto were completed. In addition, major construction work was under way in eight other Ontario cities. It is planned to supplement this large program with construction of a complete new hospital unit in south-western Ontario, as well as other additions to the existing mental hospitals.

For buildings to be used for educational purposes, teachers' colleges, echnical institutes or other educational facilities were under construcion in eight Ontario cities adjoinng universities, colleges or experiiental stations.

Plans were being worked out at ear's end to provide administrative nits for provincial police across the rovince, with a new general headuarters building in Toronto and disict headquarters buildings in stratgically located centres of which iree have been started and others re in the planning stage. A comlete new reformatory institution was earing completion at Millbrook and group of new buildings was being arted at the Burwash Industrial arm.

With the province's large highway rogram under way, typical plans or highway administrative buildings id been prepared, and nine such uildings were nearing completion or ere well under way across the provce. The many individual buildings ider construction for the Department of Lands and Forests form the isis for protection of the forest inistry and wild life including a large out rearing station at Sault St. arie. To keep pace with the conuous expansion and to provide for e services by other departments, e head office of the Department



Work started in 1956 on the latest of many attempts to reduce the navigational hazard of Ripple Rock, in the Seymour Narrows between Vancouver Island and the B.C. mainland. The Department of Public Works is carrying out a major tunnelling operation which will culminate in blasting the rock with 750 tons of explosive. The top picture shows a 1945 attempt at drilling from a scow anchored over the rock. This attempt was abandoned as uneconomical. Centre, an extension to the R. C. Harris water purification plant for the Municipality of Metropolitan Toronto. Bottom, the main fill of the St. Mary dam, Alta., part of the major government irrigation scheme. *(Photos: Dept. of Public Works; Foundation Co. of Canada; Prairie Farm Rehabilitation Administration.)*

of Public Works in Toronto has been enlarged by two new office buildings and a start will be made in 1957 on further increasing office accommodation there.

During 1956 expenditures for public works for capital account amounted to $25 million and during 1957 capital payments will approximate $31 milliion.

With slight differences in emphasis on the needs of the various departments and services, the foregoing pattern of provincial public works in Ontario is being repeated in other provinces with total capital expenditures in each roughly proportionate to population. Ontario's share of contract awards last year for public works, at $25 million, represented about 39 per cent of the total government intentions for building construction. Proportionately, Quebec's share might be expected to be about $17 million, the three prairie provinces' share would total about $10 million, British Columbia's share and the Maritime provinces' share $4.8 million and $3.8 million, respectively; making up the total of 'intentions' for Canada of $60.5 million.

British Columbia and the Maritime provinces probably had relatively more *per capita* expenditure for the benefit of the fishing and forestry industries and smaller proportions for agricultural facilities. In the prairie provinces there would be increased emphasis on facilities to serve the farming industry. Outlays for buildings such as hospitals, schools and other institutional buildings, as well as sewage and water supply facilities, would probably be comparable with Ontario on a direct *per capita* basis.

PRAIRIE FARM REHABILITATION

The prairie farm Rehabilitation Administration was set up in 1935 under the Prairie Farm Rehabilitation Act, during the severe drought of the 'thirties'. In 1937 the act was amended to increase its scope and authority, and land utilization became one of the major activities of the rehabilitation program.

The administration is a branch of the Federal Department of Agriculture, with its head office at Regina, Saskatchewan. In the summer of 1956 there were some 1050 employees; 129 of them non-graduate technicians, 177 year-round unclassified staff, and 371 seasonal employees. The engineering services are staffed with highly qualified specialists in the fields of soil mechanics and foundations, hydrology and structures, engineering geology, air photo interpretation, soil and topographical surveys, drainage, and construction.

The land utilization policy is based on a complete soil survey of the prairie provinces covering an area of 50 million acres. It provides a means of taking sub-marginal land out of cultivation and regrassing these areas for grazing purposes as 'community pastures'. Some 1,750,000 acres have so far been taken out of cultivation, and 200,000 acres have been regrassed. Sixty-one operating units at present graze 110,000 cattle yearly. Measures are also provided for control and prevention of soil drifting and erosion, for encouraging improved tillage and cropping practices, and for tree-planting.

Water Conservation

The administration's water conservation program consists of two main divisions: (1) individual and comunity projects, and (2) large water-storage and irrigation projects. The former is concerned with individual stock-watering 'dug-outs' and small dams with storage of one acre-foot of water or thereabouts, and with community projects ranging in storage capacity from a few acre-feet up to thousands of acre feet. Some 55,000 such projects have been constructed to date, most of them small individual projects.

There are some three million acres within the so-called 'drought area' of western Canada for which there are water supplies available in the rivers and so situated that they can be economically irrigated. Alberta has 783,000 acres at present under irrigation while Saskatchewan has 200,000 acres.

Surveys have been made by the PFRA for a large number of extensive projects and many of these have been or are being constructed. Notable among them is the St. Mary project for watering 510,000 acres in the Lethbridge-Medicine Hat area, now partly completed. The St. Mary Dam, built in 1950/51, is a 186 ft. high earth fill structure. Half the land in the project is now 'under the ditch'. The Federal Government has spent some $14.9 million on the storage facilities and main canals, while the province of Alberta has spent a like amount to date on the distribution system which is now about half completed. This is the typical pattern for cooperation between the Federal and respective provincial governments.

Another undertaking is the Bow River project west of Medicine Hat, taken over from the Canada Land and Irrigation Company in 1951. The project has a potential 240,000 irrigable acres of which 57,000 were then served by the ditch. The PFRA is currently undertaking an orderly rehabilitaiton of the works.

Another is the Saskatchewan River reclamation project, for reclaiming an area from annual flooding in the delta of the Saskatchewan river near the Pas, Manitoba, by means of dyking and drainage, and involving reclamation of a million acres in Saskatchewan and Manitoba. Canada's share of its Pasquia section, comprising 35,000 acres in Manitoba, is nearing completion and will soon be ready for settlement. Jointly with the Manitoba government, reclamation of the eastern slopes of Riding and Duck mountains is also being carried out, as well as flood protection along the Assiniboine river.

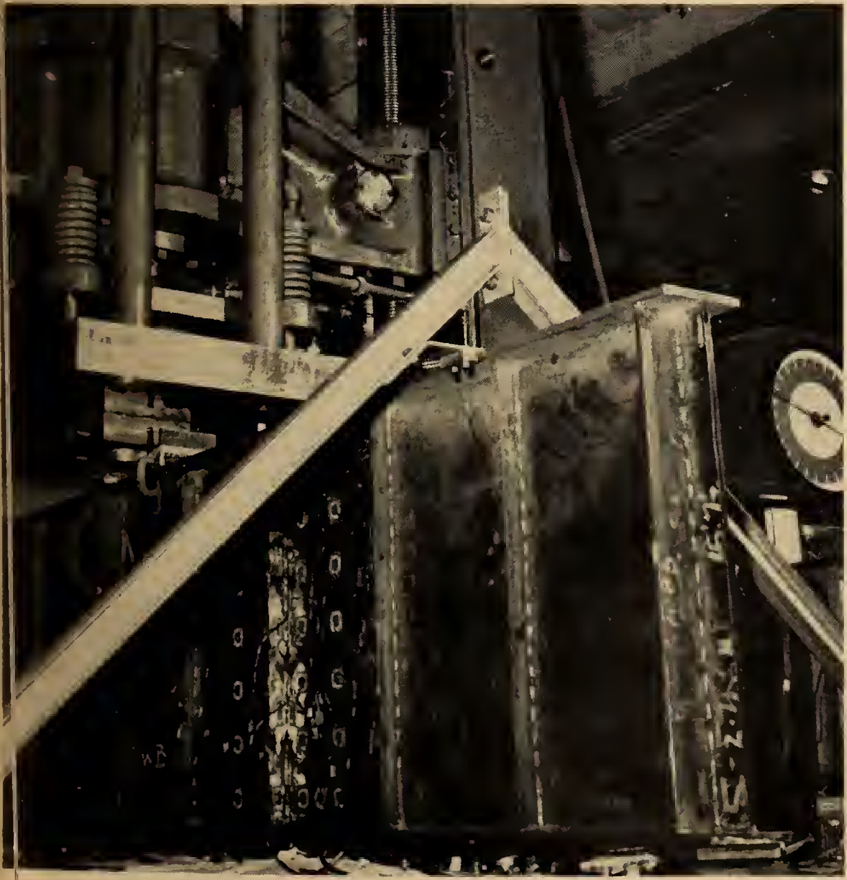
Smaller Irrigation Projects

Numerous smaller irrigation projects have been constructed in central British Columbia in cooperation with the Department of Veterans Affairs under the Veterans Land Act. One of these, recently completed in the Lilloet area under special agreement with the province, has resulted in protection of land under cultivation and in the reclamation of some 14,000 acres of additional land. In all, some 30,000 acres of high-class land were salvaged by the project.

Other major projects still under survey include the Red Deer River project in Central Alberta and the South Saskatchewan project in Central Saskatchewan. The former would irrigate some 500,000 acres, while the latter would supply water to a further 500,000 acres in Saskatchewan.

Expenditures to date by the Canadian Government through the PFRA proper are estimated at about $50 million; including special appropriations, the expenditure to date is approximately $120 million. An appropriation of $12 million is set up in the annual estimates for work to be undertaken by the Federal government in 1957/58. Figures for employment and value of work done on irrigation and drainage projects are included with the construction industry.

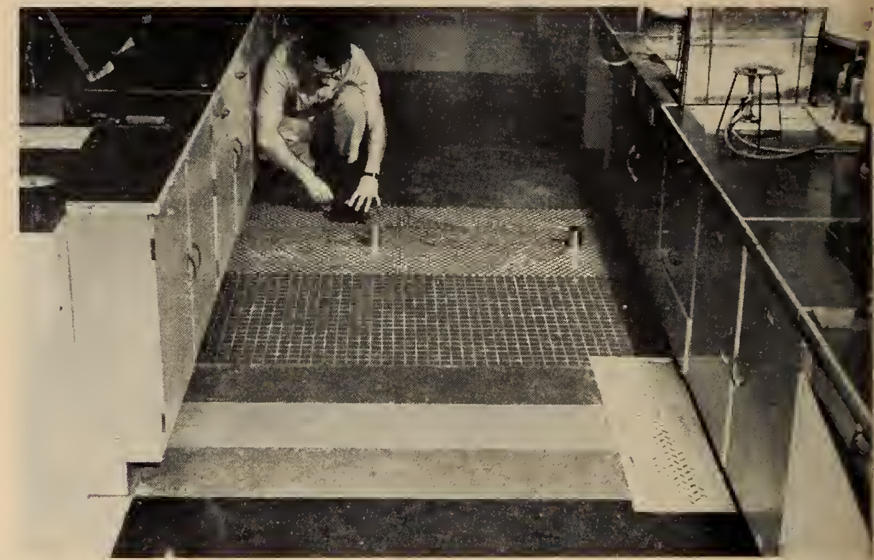
A REVIEW OF ENGINEERING RESEARCH IN CANADA



Above is one of a series of tests on conventional and trussed roof constructions carried out as part of the work of the Division of Building Research, National Research Council. At left is a test being made during an investigation into stresses in a thin-webbed steel plate girder (courtesy McGill University Engineering Library).

THE TERM engineering research is not easy to define. Professor Mordell, of McGill University, has defined it as "research done by engineers". He argues that, broadly speaking, the engineer's training embraces the same range of disciplines as that of a more fundamental scientist, and that, in his research, he resorts to the same logic and attack that the scientist employs.

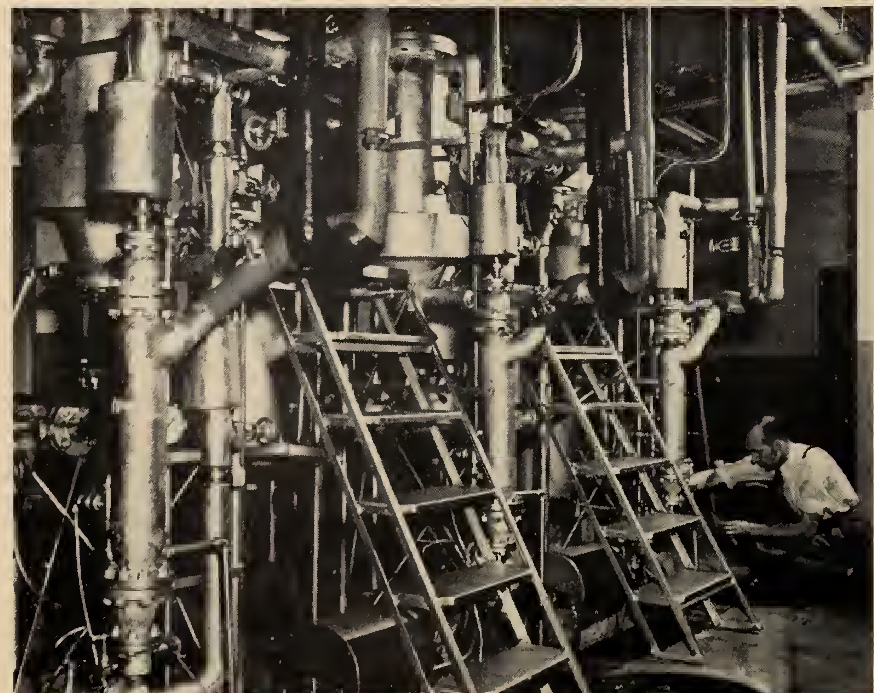
Nevertheless, the engineer's training frequently does not penetrate as deeply into the fundamental sciences and, in general, he leans to applied research rather than fundamental research. He is usually concerned with a method of applying natural laws rather than a philosophical exploration of the laws themselves. This tendency is particularly evident in industrial laboratories.



An investigation of the properties of different types of conductive flooring, for laying where electrostatic charges must be avoided; for example, where explosive gases are used. (Division of Building Research, National Research Council.)

Until recent years, Canada has been pre-occupied with the development of her primary resources and primary industries. Research in mining and agriculture developed rather early and it is only now, as an increasing tendency to process our own raw materials has developed, that research in the secondary industries is becoming more active. Several factors have affected this trend. One of the most important is the structure of Canadian industry which, to a large extent, is composed of subsidiaries of parent firms in other countries, and these subsidiaries have relied almost exclusively on the parent firms for their designs and their development. In some of the larger, independent industries in Canada, such as the pulp and paper industry, research has developed more rapidly. Most Canadian industry is now displaying an increased interest in research and a trend toward greater self-sufficiency in design. This trend appears to be essential if the industry is to obtain a fair share of foreign markets and even to maintain its own domestic market against competition from modern designs from outside the country. Another factor is that the universities were not in a position to engage extensively in engineering research. The professors rarely had time or equipment to pursue their own research and their teaching load usually precluded any possibility of their directing research of students pursuing post-graduate studies.

A battery of 2-cu. ft. experimental digesters in the chemical pulping division of the Pulp and Paper Research Institute of Canada.



Post-graduate training is desirable, and even essential in many fields of research, but there had been little or no incentive for engineers to pursue post-graduate training. Graduates with post-graduate training had no greater guarantee of employment than those without and, indeed, this condition still prevails. Post-graduate training has offered little, if any, financial attraction. The engineering position differs in this respect from the more fundamental sciences.

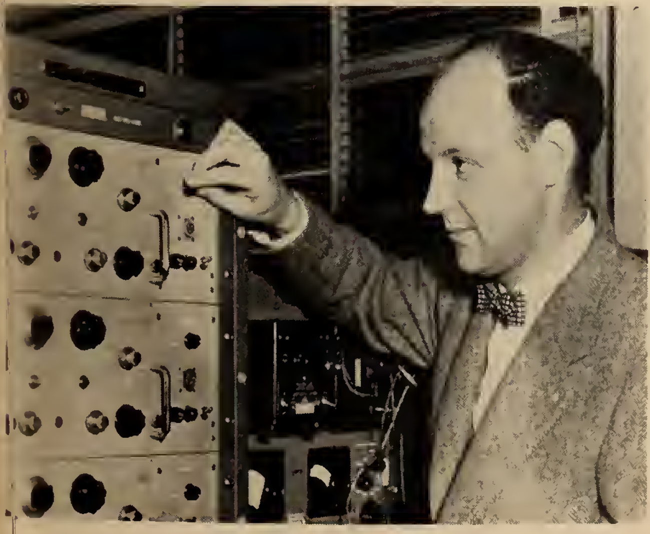
However, the situation is changing. There is an increasing demand for engineers with post-graduate training, both in industry and in the expanding system of research laboratories in the country. They need men with vision, creative ability, originality, and a sound understanding of science, who can introduce new concepts into design. They need men who can expand the frontiers beyond present-day textbook design; they need men who can make new textbooks possible.

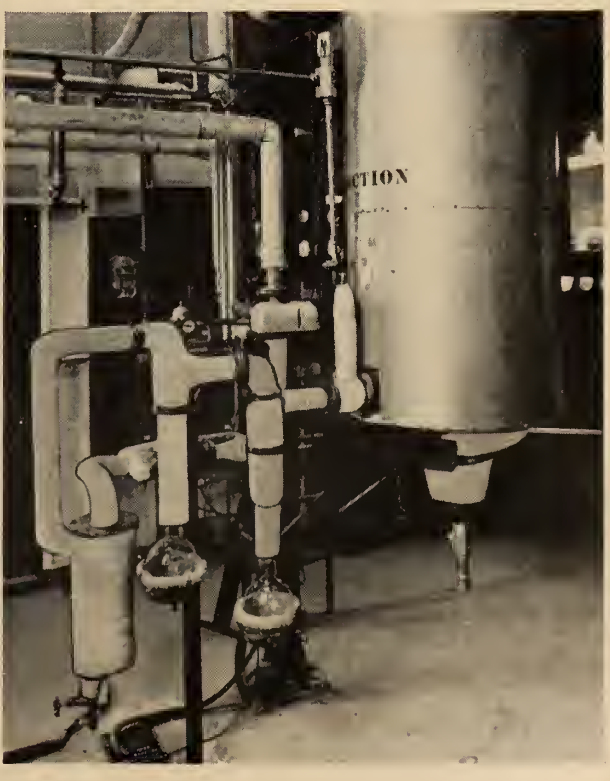
Prior to World War I, there was practically no engineering research in Canada, although there was an occasional notable exception such as the work of Alexander Graham Bell on aeronautics at Baddeck, Nova Scotia. The National Research Council which began its activities in 191 had contributed importantly to scientific research, but its efforts until recently have been devoted mainly to the more fundamental sciences. Its early efforts were confined to the ıward of grants in aid of research ınd scholarships to students pursuing post-graduate work. The grants enıbled university professors to undertake their own research by providing noney for the purchase of equipment ınd to engage students or others to ıssist them. At that time the total National Research Council expendiure on grants and scholarships ımounted to about $100,000 annuılly. More recently, there has been ı marked increase in assistance to ıniversities for research, not only rom the National Research Council ıut from several other sources. The National Research Council alone is ıow contributing directly or indiectly approximately three million lollars annually for this purpose. Support has been increased by a factor of six since the end of World War II.)ther organizations, such as the Deence Research Board and Atomic Energy of Canada, are making imıortant contributions and industries re assisting.

However, the percentage of this upport which has been expended on ngineering research has been disppointingly low, and even now, debite increased emphasis on this hase of research, does not exceed 0 per cent, but an encouraging aspect is that the effort is growing more rapidly than that for all other scientific research.

Occasionally Canada is compared unfavourably with other nations with respect to the effort which she devotes to research. It is true that some other countries are more active, but Canada's position is by no means low on the scale. Unfortunately, it is difficult to assess the true effort in Canada or in other countries. Government expenditures on research are fairly well known, but it is difficult to separate military expenditures from non - military expenditures, and, where governments award research and development contracts, it is not always possible to determine how much of the effort is devoted to conventional engineering design of a new device and how much to investigational work which might properly be called research or development. But, if the problem is difficult in the case of governments, it is much more so in the case of industry. In Canada, the total expenditure by government on research in the fiscal year 1956-57 amounted to approximately 105 mil-

bove, a method of measuring pulpwood boom strain with SR-4 auges on a test bar; right, a small pilot-plant reactor for the omized suspension technique, a new method developed for ringing liquids and solids into thermal reaction; both are amples of the work of the Pulp and Paper Research Institute f Canada. Below, the Radio Physics Laboratory, a Defence esearch Board establishment, in 1956, announced a communiations technique for long-distance transmission of radio signals y reflection from ionized trails of meteors.





lion dollars. An additional 30 million dollars was expended on defence development contracts and this total figure corresponds to a *per capita* expenditure of approximately $9.00. Of the above total, non-military expenditure accounts for approximately 80 million dollars corresponding to a *per capita* expenditure of $5.40. In the United States, the total *per capita* expenditure on research is about $13.70, whereas that in Great Britain is about $11.00 *per capita,* at $2.80 to the pound.

Considering the fact that the figure for Canada does not include money paid to parent firms outside of the country for research and development, it does not compare unfavourably with that in the other two great industrial nations mentioned. Nevertheless, the comparison is based on the total expenditure on research. If it were restricted to industrial research, it is probable that the Canadian position would be somewhat less favourable, but unfortunately no reliable data are available.

All research laboratories, whether government, industrial, or university, are confronted with the problem of recruiting staff and no discussion of research would be complete without some consideration of this very vital factor. The proportion of Canadian population obtaining a degree in science or engineering is about 220 per million. As far as can be determined, only three countries in the world exceed this figure, namely the United Kingdom, Soviet Russia, and the United States. The ratio in the United Kingdom is not significantly greater —certainly less than 10 per cent greater, although in the United States and Russia the ratio is something over twice that of Canada. Here again, the Canadian picture is not too unfavourable.

The fact remains, however, that there has been a very heavy demand for engineers which the universities have not been able to fill. Those who visit university campuses for the purpose of recruiting staff will appreciate the keen competition for graduates. Unquestionably, Canada can absorb the entire university output of engineers and it appears that there will be an increasing demand for some years to come. The universities are endeavouring to meet this challenge. New universities are emerging and existing institutions are enlarging their training activities. Some universities which have not heretofore given training in engineering are now developing degree-granting courses. It is important, also, to insure that an adequate supply of high school students will be available to the universities to make this expansion of facilities worthwhile. Certainly the high schools are expanding at a rapid rate, and it appears likely that the present popularity of the engineering profession will attract many high school students.

Salaries are, of course, always an important factor. Engineering salaries are, in general, comparable with those of other professions in Canada. Engineers in private practice have approximately the same income as members of other professions in private practice, although a greater percentage of engineers are engaged on salary as compared with other professions. The annual income of a salaried engineer is generally lower than that of an engineer in private practice, but this condition is compensated somewhat by a reduction in risk and by the usual fringe benefits of retirement pension, and sick benefits which are associated with a salaried status.

We are in direct competition with organizations in the United States for the services of engineers, and there is definitely a migration of Canadian engineers to lucrative research posts in the United States. However, the Canadian salary structure for research men is approaching that of the United States, particularly for junior engineers, and it is likely that the two will become more nearly comparable. Even so, it is interesting to note that the loss of engineers to the United States is more than balanced by incoming European engineers who are well qualified in training and experience.

In conclusion, the rapid expansion of research in Canada and the promise of a greatly increased interest in engineering research is encouraging. Expenditure on research by industry is still relatively low, but there is a tendency for Canadian industry to become more self-reliant and to undertake a greater and greater percentage of their own design and development. It is to be expected, however, that a significant percentage of research will continue to be undertaken by parent firms and it is probable that government research organizations will continue to perform a higher percentage of the total applied research than in most other industrial nations, although government research organizations are encouraging industry to undertake their own research because it is believed that this is much more effective than research undertaken by a separate body, whether it be government or university. Research is attracting an increasing number of engineers. Industry, universities and government are co-operating to provide increased training facilities and to encourage increased enrollment.

ACKNOWLEDGMENTS

The Engineering Journal wishes to acknowledge the assistance and support received from the many contributors to this issue. It is not possible to refer to them in detail, but they include many federal, provincial, and municipal government departments; the armed services; universities; National Research Council; Canadian Construction Association; Canadian Pulp and Paper Association; Pulp and Paper Research Institute of Canada; *Pulp and Paper Magazine of Canada;* The graphical presentations are taken from the Dominion Bureau of Statistics. Much of the material has been prepared, and other assistance given, by H. G. Cochrane, M.E.I.C.

TRANSACTIONS

As announced in the annual report of the Publication Committee, circulated with the April issue of *The Engineering Journal*, Council has approved the publication of *Transactions* of the Institute. This will contain only technical material and, in the first instance, will be sent to all *Journal* subscribers. The first issue is to appear shortly.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE ELECTIONS AND TRANSFERS

The Journal in the House of Commons

Recently in the House of Commons there was a discussion about the proposal to increase the grants to the universities. This finally got around to consideration of the shortages of engineers and scientists and to quoting the *Engineering Journal.*

It is interesting to see that the subject which has been discussed by the profession and by employers has at last reached the floor of the House. Also it is interesting to see the personal knowledge the Prime Minister has of the subject, as illustrated by the reference to his friends and associates and their sons in the City of Quebec.

The following is quoted from Hansard of January 29, 1957.

"**Mr. Green:** Will the Prime Minister bring us up to date concerning the situation with regard to engineers and scientists? We all realize that this vote provides for payments without any conditions direct to universities but we hear most alarming reports from time to time about the great shortage of scientists and engineers. For example, there was a report published last week by the Engineering Institute of Canada with reference to the alarming current and prospective shortage of Canadian engineers and scientists. This paragraph appeared in the press report.

More words have been spoken and printed about this situation than about most anything else. Many voices have proclaimed the urgency, but after years of talk no one has done anything of consequence that will improve the situation quickly.

"And again:

There is some promise now that government and industry will help, but the needs appear to be away beyond any sums that are being mentioned as available shortly.

"We all know how important scientists and engineers are to Canada at present and in the years immediately ahead. Can the Prime Minister tell us what is the opinion of the government with regard to all this talk of an acute shortage, and if there is such a shortage whether any steps are being taken to meet it?

"**Mr. St. Laurent (Quebec East):** I cannot give any precise figures to the hon. gentleman. At the present time there are indications of intentions to provide structures of various kinds to a total amount that would be beyond the capabilities of the available scientific or engineering or skilled or unskilled manpower, and greater than the materials available. There is a certainty that not everything that Canadians and Canadian corporations would like to do or have expressed intentions of trying to do during 1957 can be accomplished.

"**Mr. Green:** Because of the shortage of trained men?

"**Mr. St. Laurent (Quebec East):** Because the total is greater than the population of this country, with its savings and even the savings that come from abroad, with its manpower and its materials, can realize in the one year. During last year I understand the amount of capital investment was of the order of about $7.75 billion. Estimates that have been gathered for what I believe are called intentions for the present year would indicate an increase of as much as 12½ per cent over what was realized in 1956. Of course that would not necessarily be 12½ per cent in actual volume because there is an expectation that prices over the year in the construction trades —the capital investment trades — are apt to be as much as 5 per cent higher than in 1956. That would still leave an actual physical increase of 7½ per cent over what was realized in 1956, and my information from the data available to our experts, and their best estimates, is that this is more than the economy can produce.

"Now, with respect to the so-called shortage of engineers, I know there is a greater demand for engineers than there was when either the hon. gentleman or I were at university. Just as one illustration of what I have in mind let me mention this. The hon. gentleman knows the reputation of the Taschereau family in the province of Quebec; it was always producing either clergymen or lawyers or judges. That family has supplied a number of very distinguished clergymen to Canada. The first cardinal was a Taschereau. They have supplied a number of very distinguished judges, and a still larger number of brilliant members of the bar in the province of Quebec. A Taschereau was my partner when I was at the bar. He has only one son, and the son, instead of following in his father's footsteps as has been done for generations by male members of that family, is studying to be an engineer.

"This is because there is now a realization among the young people that there is a greater demand for engineers, and consequently there are more young people adopting the vocation than formerly. I feel therefore, that there will be a greater number of engineers in the future. There will be a greater demand upon the universities to train engineers, and I know that right here in Ottawa there has been a very substantially filled subscription list in response to an invitation to Quebec and Ontario industrialists to contribute to the establishment of an engineering faculty at the University of Ottawa. They are doing this because they feel their businesses will require that kind of equipment. It is just as essential to their businesses to have trained staff as it is to have the machines which they install in their plants. It is, I think, a very encouraging sign that our industrialists should be realizing, as I said, a moment ago, that the greatest of our natural resources are our human resources, and that these human resources have to be developed and cultivated if we want to make full use of the other material resources with which our land is blessed."

Victory For The Self-Employed

Many members of the Institute will have been made happy by the recent announcement of the Federal Government that self-employed workers will be permitted to make income deductions for tax purposes for monies which they have paid in to recognized pension plans.

As conditions were, a person who was employed by a company which had a recognized pension scheme could deduct his contributions from his income for tax purposes, but a person who was working for himself, such as a doctor, a lawyer, dentist, a consulting engineer, or a business man, was denied this privilege.

Upon being informed by the general secretary of the Canadian Medical Association that the Association, along with l'Association des Medicins de Langue Francaise du Canada, was petitioning the Federal Government to have this situation overcome, the Council of the Institute approved of a proposal to join the others in petitioning the Minister of Finance.

This new regulation of the Finance Department will mean considerable to a great many consulting engineers in Canada and to many members of the Institute who, though not actually in engineering at the moment, are heads of their own businesses of one kind or another.

The Institute is indeed proud to have been associated with the sister societies in so worthy an effort.

Field Secretary for Western Canada

The four western provinces are a long way from Montreal. It is not easy to take care of the Institute's responsibilities in that part of Canada from so great a distance or by occasional tours of the president and the general secretary. Consequently for some time consideration has been given to opening a district office there.

It is possible now to announce that a field secretary for Western Canada has been appointed. He is Commodore (E) A.C.M. Davy, R.C.N. (retired) M.E.I.C. He will make his headquarters in Vancouver but will visit branches and members throughout the four western provinces. His services began on May 1.

A. C. M. Davy, M.E.I.C.

His address is: 1370 Minto Crescent, Vancouver 9, B.C.

Commodore Davy is well known across Canada and in his travels will meet many of his earlier associates. The Institute is confident that with such a competent person available full time, much useful work can be accomplished in the West. Branches are urged to use Commodore Davy's advice and services, whenever they may require them.

Commodore Davy retired last June from an active naval career after thirty-nine years' service.

Originally from Montreal, Commodore Davy attended naval college at Halifax and then went on to England for training at the Royal Navy Engineering College at Devonport, England in 1923.

He has held numerous appointments at sea and at naval stations across the dominion, at Halifax, Esquimalt, Vancouver and Kingston. Through the years he has also served as director of naval engineering with the Department of National Defence, Ottawa in the early thirties, and, during World War II, held the responsibilities of wartime director of shipbuilding for the R.C.N.

In 1946, then a captain, he was among those honoured with the award of the O.B.E.

Commodore Davy was appointed deputy chief of naval technical services and engineer in chief at naval headquarters, Ottawa, in 1949.

Distinguished Visitor to Canada

Many Canadians had the opportunity recently of hearing Sir Claude Gibb during his Canadian tour.

In London, Ont., he was entertained by the president of the Institute, V. A. McKillop. In the picture below: Mr. McKillop, Sir Claude Gibb, and D. J. Matthews, chairman of the London Branch. This important tour will be reported in June.

Spectacular Nuclear Congress

If size is a measure of importance, the 1957 Nuclear Congress was important. Doubtless there are many other and more significant standards by which to judge a meeting, but thinking in terms of size leads to figures which can be grasped more readily than other characteristics.

The 1957 Congress produced these figures. The technical program was made up of 282 papers, panels and addresses, with 450 people listed as authors or speakers. The total registration was 7000. In the exhibition there were 125 exhibits.

The Congress was a getting together of four separate groups who for several years have been interested in the studies and practices in the nuclear field. Firstly, there was the Second Nuclear Engineering and Science Conference, then the Fifth Atomic Engineering in Industry Conference, then the Fifth Hot Laboratories Equipment Conference and lastly the Third International Atomic Exhibition.

The Congress, which was held in Philadelphia, extended over five days — March 11 to 15. Most of the meetings were held at the gigantic Convention Hall, but some of those arranged by the National Industrial Conference Board were held at the Benjamin Franklin Hotel. The exhibition naturally enough was in the Exhibition Hall section of the Convention Hall. It was a tremendous show but that it required less than half of the floor space of this one section of the convention centre.

The Congress was sponsored by 26 engineering and scientific bodies including The Engineering Institute of Canada. To show the extent of the interest in the subject and the support for the Congress the names of these organizations follow:

American Chemical Society
American Geological Institute
American Institute of Chemical Engineers
American Institute of Electrical Engineers
American Institute of Industrial Engineers
American Institute of Mining, Metallurgical & Petroleum Engineers
American Institute of Physics
American Nuclear Society
American Rocket Society
American Society of Civil Engineers
American Society for Engineering Education
The American Society of Heating and Air Conditioning Engineers
The American Society of Mechanical Engineers
American Society for Metals
American Society for Testing Materials
American Water Works Association
Engineering Institute of Canada
Federation of Sewage & Industrial Wastes Associations
Health Physics Society
Institute of the Aeronautical Sciences
Institute of Radio Engineers
National Industrial Conference Board
Society of Automotive Engineers
The Society of Naval Architects & Marine Engineers
The American Public Health Assn.
Hot Laboratories Committee.

Nuclear Congress, 1957. This photo shows a portion of the head table of the all-congress banquet, March 13. The Institute's official delegate was Dr. R. E. Heartz, shown third from the right end. Reading from right to left, here are the other delegates: Karl Z. Morgan, president, Health Physics Society; Emil C. Jensen, president, Federation of Sewage and Industrial Wastes Associations, Dr. Heartz; R. A. Schatzel, president, American Society of Testing Materials; William F. Ryan, president, American Society of Mechanical Engineers, Elmer R. Queer, vice-president, American Society of Heating and Air Conditioning Engineers; Marion W. Boyer, member, Nuclear Congress Policy Board; Rev. John Robbins Hart; Lewis R. Gaty, chairman, Philadelphia Committee, 1957 Congress; W. Kenneth Davis, director, Division of Reactor Development, A.E.C.

The Engineering Institute of Canada is proud to be in such good company. It is the hope of the Institute that by such association in so important a study, much valuable information and many important contacts may be made available to Canadians.

The Institute was represented officially by the immediate Past-President, R. E. Heartz, president of Shawinigan Engineering Company. In view of the president's inability to be present, it was a fortunate circumstance that made it possible for Dr. Heartz to represent him, for Dr. Heartz is himself deeply concerned in nuclear matters and his company is active in the field of design.

It will be difficult in an account of this kind to list all the papers and speakers, but members will be interested to know that the complete set of papers will be in the Institute library. Those who are interested may borrow a copy of the 75-page program from which to select the papers they would like to see. The library will be ready at any time to send on loan those which may be selected. If a member desires to purchase copies the library will supply them as long as they last. In any event photo copies can be made by the library.

It is planned that some of the papers will be published in *The Engineering Journal*. The entire group will be submitted to the Publications Committee for selection of those of most interest to Canadian readers.

1958 Nuclear Congress

The 1958 Nuclear Congress will be held in Chicago from March 17 to 21.

The Engineering Institute of Canada will again be one of the sponsoring organizations. Members of the Institute may obtain through the Institute all the information including registration forms, programs, etc., that will be required. The planning of the congress will be reported from time to time in *The Engineering Journal*.

Any member of the Institute wishing to contribute a paper to this congress should communicate with Headquarters as soon as possible indicating the nature of the subject in which he is interested and the manner in which he proposes to handle it. Preliminary abstracts of proposed papers must be turned over to the Planning Committee by July 15th, 1957. The theme of the congress will be "Industrializing the Atom".

"Daylight Through the Mountain"

This is the title of the book which the Institute is publishing shortly telling in considerable detail the story of the lives of Walter and Francis Shanly, two pioneer Canadian engineers.

As has been stated earlier the book will be unique in the annals of Canadian engineers. It will become a permanent part of the history of the profession as well as the history of Canada. Canadian engineers now reading of the great projects of these early pioneers will be just that much prouder of their profession.

By way of interesting members of the Institute in the publication, the *Journal* will publish from time to time short extracts from it. The following material has been supplied to us by the author of the publication, Dr. Frank N. Walker. The story of the Hoosac Tunnel is indeed one of the highlights of early engineering in North America. The fact that several other engineers and contractors failed to complete the work adds just that much more glory to the Canadians who did it "with colours flying". Herewith is Dr. Walker's reference:

The Hoosac Tunnel Project

The "Western Railroad", now the *Boston & Albany*, was built through the *Green Mountains* in the early 1840's. Its grades and curvature were such that many people thought that it could never carry freight in such quantities as the anticipated prosperity of Boston would demand; so attention was turned to the *Mohawk Trail*, further north. There the water-shed between the Hudson and Connecticut Rivers was only five miles across, but it took the form of the Hoosac Mountain which rises to over 1,000 feet above the surrounding country. In 1847, a scheme was put forward to tunnel through this obstruction and charters were obtained to allow such work. This began in 1851 and proceeded with a series of disasters, financial failures and organized opposition until 1868.

In that year the Legislature of Massachusetts decided to offer an over-all contract for the completion of the wôrk and voted $5,000,000 to see the thing through. Francis Shanly, who was in Nova Scotia investigating the possibilities of the prospective Intercolonial Railway, received an invitation to tender on the Tunnel in June, 1868. This he did in conjunction with his brother Walter; but they did not get any encouragement until October when a long expensive grind of meetings and discussions began at which the opponents of the venture were given a very free voice.

In the letter which follows, Walter Shanly writes to his brother on Christmas day from Montreal where he had just arrived that morning after finally signing the contract.

Montreal, Xmas day, 1868.

My dear Frank;

I arrived here this morning, just a fortnight away. I telegraphed you from Boston yesterday to say that the "Broad Seal" of Massachusetts was affixed at 3 p.m. Enclosed you have a complete copy. Only the most dire mismanagement and blundering can prevent our making more out of this thing, at its worst, than we can reasonably hope to make in any other way within the next five years. The letting has caused a widespread commotion. Men turned round to look at me and point me out in the streets, of Boston, the last few days, as one on whom great good fortune had fallen. Heaps of letters already from the poor and needy: I have not time now for discussing details, but we must have an early meeting to lay down the plan of campaign. I shall probably have a call early next week to meet Wentworth, or someone else on the work, to go into the question of properties and take over such things as we require.

I wrote you a day or two ago to say that A. T. Galt had been making overtures to be let in. Subsequently he sought me out again and put the thing in definite shape. He could put in of himself $125,000 U.S. currency, and undertake all the rest of the financing; a good offer. Of course, he wants to see the Contract before closing; and I, on my side, said, I would have to consult you before entertaining any proposition. He is to be here Tuesday. Try and be here too. Prompt action is absolutely necessary. From and after Monday next we will be under $25 a day expenses pumping Central Shaft, which the Commonwealth have kept going ever since the bodies were taken out. That part of the work must be let and I think Alex. S. Brown, of Belleville, is the man to do it. I will write him today to ask if he is still prepared to make me an offer. He told me (in Halifax) that he would do so, saying that he felt sure we would have the work. Wentworth told me that the Council might better have closed with us two months ago, as they had all made up their minds from the first day we were before them that we were to do the work! If there is any of the Old Fire left in us, we must wake it up in this Hoosac business.

I believe we can let DAYLIGHT THROUGH THE MOUNTAIN in *four* years, and that, if we do, we can easily get a bonus of $100,000 from the State. There is one strong point in our favor, *everyone thinks it is a great Contract;* and that is CAPITAL in itself . . . Telegraph me on receipt, as to whether you can be here Tuesday.

As ever yours,
W. Shanly.

Hungarian Students in Toronto

Ninety refugee Hungarian students, are the guests of the Ontario Government and the mining industry of Ontario, at Chorley Park, Toronto.

For the most part from the University of Sopron, they arrived in Canada in January.

Having undertaken an intensive training in English under the sponsorship of the Ontario Department of Education, these students hope to have attained sufficient facility in English to be accepted into various engineering courses at the University of Toronto in September.

Professor H. R. Rice of the Faculty of Applied Science and Engineering, who is chairman of a committee planning their integration into the university, wrote to the *Journal* in March. At that time the students were being introduced to English texts and periodicals, and supplies of technical magazines were being solicited from various sources. The Institute was only too pleased to send an adequate number of subscriptions, and to commend all concerned for the hospitality offered to these very deserving students. The Institute president and general secretary had the opportunity of speaking to some of the young men during a recent visit to the University.

They would be going into summer jobs about the middle of June. Prof. Rice reported, and the Chorley Park establishment would be closed. The students would not be together again until they enter the university in the fall.

Life Members Meet

Once again the Life Members in the Montreal area held a social evening in the auditorium at Headquarters. The date was Friday, March 22.

Following the pattern created last year the meeting took the form of a series of films. At 5.30 a buffet supper was served and by 6.30 the films were in process.

Three films were shown, the first one being on automation, the second one a recruiting film loaned to the Institute by the Institution of Electrical Engineers, called "Inquiring Minds", and the third one a newly acquired film donated to the Institute's library by the Hydro-Electric Power Commission of Quebec. It was called "Beneath the Broad St. Lawrence". The whole performance was over precisely at 8.00 o'clock.

There are 708 Life Members in Canada. The thought has been expressed that similar "parties" might be held by Life Members in other parts of Canada. Already arrangements are under way for one in Toronto, but the Life Members Committee would be interested in hearing from other centers which may be interested in similar gatherings. Such letters should be sent to J. A. Freeland, M.E.I.C., secretary, Life Members Committee, c/o The Engineering Institute of Canada, 2050 Mansfield Street, Montreal 2.

Elections and Transfers

At the meeting of council held at Montreal, April 13, 1957, a number of applications were presented for consideration and on the recommendation of the Admissions Committee, the following elections and transfers were effected:

Members: L. J. Alfreds, London, Eng., H. W. Alting-Mees, Peterborough; R. P. Armstrong, Montreal, R. N. Bartlett, Montreal, L. R. Bechamp, Montreal, G. M. Binnie, London, Eng., J. A. T. Bousfield, Montreal, C. T. Carson, Walkerville, A. G. Carter, Hamilton, A. Compare, Montreal, F. V. Drowley, Clarkson, M. Dufour, Montreal, K. M. Ed, Montreal, C. K. Fraser, Peterborough, R. E. Frischknecht, Montreal, F. D. Hall, Vancouver, K. T. Harris, Arvida, D. J. Hilton, England, G. S. Jardine, Cornwall, F. R. Jeffery, Lachute, J. C. Kingston, Montreal, B. T. P. Lewis, London, J. E. M. MacAllister, Montreal, I. A. MacLean, Calgary, I. C. MacNabb, Calgary, A. H. McCallum, Montreal, N. M. McCallum, Lethbridge, A. McDougall, Baie Comeau, J. J. Magill, Walkerville, P. M. Meis, Calgary, R. H. Meier, Ottawa, J. P. Pickard, Cornwall, G. W. Redwood, Shawinigan Falls, K. E. Rolison, Toronto, M. D. Saunders, Montreal, G. A. Stone, Bird, Man., R. E. Walker, Montreal, J. S. Whitton, Vancouver, G. G. Wotton, Granby.

Juniors: R. W. Beneteau, Windsor, W. R. Bishop, Edmonton, T. O. Maginess, Hamilton, J. C. Nicholson, Arvida, H. R. Paterson, Montreal, A. J. Rensaa, Edmonton, C. P. von der Weid, Montreal.

Junior to Member: J. A. Brown, Fort William, R. H. Currie, Vancouver, J. C. Davidson, Sherbrooke, P. Donato, Sarnia, J. C. Holden, Montreal, J. H. Jackson, Morrisburg, E. B. Lindsay, Montreal, W. A. McDill, Ottawa, R. L. Pellatt, Brantford, H. G. Rindress, Montreal, S. L. Sachs, Montreal, R. G. Smith, St. Vincent, B.W.I., R. G. Smylie, Vancouver, J. M. Takacs, Windsor, M. G. Tallon, Toronto, D. Wermenlinger, Quebec.

Student to Junior: K. C. Booth, Montreal, J. M. Katrusiak, Montreal.

Students Admitted:

Nova Scotia Technical College: G. L. Basso, R. R. Butterworth, J. F. Cahill, A. S. Cohen, G. F. D'Eon, L. E. Deveau, J. D. Devlin, R. J. Edwards, W. J. Ernst, J. S. Gaunce, B. L. Giffin, T. S. Goodyear, R. J. Goosney, G. C. Himmelman, G. H. Jenkins, J. R. D. Kaulbach, A. E. King, D. H. Kirby, G. W. Kyte, B. A. Leger, R. D. MacDonald, E. V. MacInnis, H. B. McCabe, R. N. Pereira, H. J. Porter, R. G. Slaunwhite, V. G. Stewart, J. G. Tourneur, C. E. Weaver, W. G. Wells, D. H. Whitman.

University of Alberta: R. N. Briggs, G. C. Byrtus, J. M. Chittick, G. A. Clark, H. C. Dickout, R. Dubas, G. W. Ellis, A. B. Fox, J. N. Fry, S. E. Lawrence, A. E. Munz, J. Shymoniak, D. J. Taylor, G. E. Vincent, A. V. Widholm, D. Williams.

Queen's University: L. R. Baker, J. A. Bennett, T. Bonnema, S. R. Buchanan, C. W. Dingham, G. R. Duff, B. E. C. Joyce, P. G. Mallory, J. S. Marling, D. G. McNaughton, I. W. Schaub, D. N. Stevens, R. N. Zwicker.

University of New Brunswick: R. J. Gallant, G. T. Hayes, J. S. Luffman, C. T. Page, J. D. Paton, G. L. Peer, F. R. Wood.

University of Toronto: F. J. Forbes, A. H. M. Jones, D. J. O'Connor, N. M. Seagram.

St. Mary's University: B. V. C. McKoy, B. G. W. Peter, B. E. Wayland.

McGill University: P. P. Attobrah.

Royal Military College: R. G. Ross.

Mount Allison University: G. W. Felszegi.

Graduates: R. E. Dowling, B.Sc. (Elec.) Alberta, 1956; E. G. Bazeley, B.A.Sc. (Mech.) British Columbia, 1956; K. Vincent, B.A.Sc. (Elec.) Toronto, 1956; A. L. E. Schluter, Student, C.P.E.Q.; James Wilson, A.R.T.C. (Hons.) Royal Coll. of Science and Technology, 1956.

Applications through Associations

By virtue of the co-operative agreements between the Institute and the Associations of Professional Engineers, the following elections and transfers have become effective:

ALBERTA

Members: P. H. Bouthillier, E. E. Cocklin, M. W. Dewis, H. L. Farney, R. A. Fisk, G. Ford, J. A. Green, G. R. Haun, R. M. Helmer, H. A. Hornfelt, D. G. Pearson, R. R. Steiner, B. G. J. Thoms, R. P. Thurston, A. F. Tottrup, R. Walker.

Junior to Member: W. Buryniuk, A. P. Foster, J. P. Walsh.

Student to Junior: J. Sveinunggaard.

SASKATCHEWAN

Members: J. S. Anderson, A. C. Armstrong, F. L. Blackhall, G. W. D. Kermode, J. J. McCartan, D. F. Matheson, K. T. Matheson, G. E. Merritt, D. C. Nellis.

Juniors: D. B. Dundee, C. Steffensen.

Students: W. W. Boucher, R. E. Isted, J. G. McHattie, R. E. Stauch, K. B. Woodhouse.

Junior to Member: D. A. Bailey, G. H. Dash, R. Jones, J. P. Kot.

MANITOBA

Members: S. C. Irving.

Junior to Member: W. L. Garvin, W. R. McQuade.

NEW BRUNSWICK

Member: J. W. Wilson.

Junior to Member: H. N. Dixon, E. R. Quinn.

NOVA SCOTIA

Member: W. M. McDonah.

The Seventy-first Annual General and Professional Meeting of The Engineering Institute of Canada

June 12, 13, 14, 1957
Banff Springs Hotel, Banff, Alberta

The meeting will be a good one, and members are encouraged to come. In the Preliminary Program, mailed to all members about the end of April, information was given about accommodations, registration, transportation, and special events. These are some further program notes.

Annual Meeting Notes

REGISTRATION

Advance registration is the most satisfactory. Registration forms must be sent to reach Institute Headquarters in Montreal by Saturday, May 25, and thereafter to the Banff Springs Hotel. The form in the middle of the Preliminary Program booklet should be used for this purpose. Members may also register during the meeting. Registration opens at 3.00 p.m., Tuesday, June 11, and continues on Wednesday at 9.00 a.m.

LADIES' PROGRAM

Mrs. H. M. Hunter, chairman of the Ladies' Committee, has written a message to the ladies, offering gracious hospitality. Her message, printed in the Preliminary Program, indicates how much there is to enjoy about a visit to Banff for the annual meeting.

There will be a special meeting on Wednesday morning June 12 to consider the setting up of a national association of engineers' wives.

COUNCIL MEETING

An annual meeting of Council will be held at 9.30, Tuesday morning, June 11.

CONFERENCES

Students' and branch officers' conferences will start at 9.00 and 9.30 Tuesday morning.

ANNUAL GENERAL MEETING

Members are invited to attend the annual general meeting at 10.00 a.m. Wednesday, June 12.

SOCIAL EVENTS

The President's Dinner will be Tuesday evening, June 11, for outgoing, incoming and continuing Institute officers and special guests (with ladies).

There will be a get-together reception for all visitors on Tuesday evening commencing at 8.30 p.m.

There will be dancing every night at 10.00.

Dinner on Wednesday will be preceded by a reception at Muriel's Room at 6.30. The speaker at dinner will be V. A. McKillop, president of the Institute.

Refreshments at 6.30 p.m., Thursday, at Muriel's Room precede two dinner meetings. For the "Petroleum Dinner", the speaker will be C. O. Nickle, M.P., Calgary. The Association of Consulting Engineers of Canada will have their annual dinner at the same time.

Special entertainment, "The Pipe Line Musical Review" at 9.00, is another Thursday evening feature attraction.

The annual banquet at 7.30 Friday evening will have as speaker Mr. Justice S. Freedman, Court of Queen's Bench, Manitoba. The new president, C. M. Anson will be introduced, and new

Annual Meeting Notes

members of Council. The annual dance follows, at 10 o'clock.

All places at the annual banquet will be reserved. Members who desire to be seated with friends or in special parties must provide full particulars with advance registration. Otherwise places will be allocated by Headquarters staff and in the order in which they are received.

LUNCHEONS

Luncheon on Wednesday and Thursday will be informal, with no speakers, except for a short welcoming address on Wednesday.

The Friday luncheon will be the occasion for presentation of Institute medals and awards.

GOLF TOURNAMENT

The Banff Springs course will offer a challenge to all golfers. It is one of the world's best. The golf tournament is set for 2.00 p.m., Thursday.

SCENIC BUS TOUR

A tour by bus from Banff is scheduled for Thursday, June 13. Starting at the hotel at 1.45 p.m., there will be a drive through Banff, and on to Lake Minnewanka, passing the Cascade Plant of Calgary Power Ltd. Coming back through Banff, the trip will take the route up to Mount Norquay, where tea will be served.

CAMBIE MEMORIAL

At a time to be announced later, there will be the unveiling and dedication of the Institute's plaque to honour the late Henry John Cambie, M.E.I.C., a distinguished pioneer engineer of Western Canada.

TRIP TO JUMPING POUND

On Saturday, June 15, there will be a trip to Jumping Pound if a sufficient number of members express interest. Jumping Pound is within reasonably easy range of Banff, about ten miles off the Banff-Calgary highway. This Shell Oil Company gas and distillate field, set up to process approximately 100 million cubic feet per day of raw gas would provide an interesting field trip.

TRANSPORTATION

Railway, air, and automobile transportation is covered in detail in the Preliminary Program. Of particular interest is the possibility of a special train to take passengers westward after the meeting to Vancouver. The advance registration will determine the practicability of this feature.

Alberta Committee

W. A. Smith, chairman; D. C. Jones, S. J. Hampton, vice-chairmen; J. J. S. Harris, A. J. Branch, members; J. A. Webb, secretary treasurer; J. S. Neil, entertainment; F. L. Perry, meeting arrangements; D. C. Hutchinson, Muriel's Room; P. A. Brett, publicity; T. D. Stanley, plant visits; J. J. Hanna, reception, J. McGill, transportation; Mrs. H. M. Hunter, ladies.

Technical Program

The technical program starts on Wednesday, June 12, at 2.00 p.m. A selection of 35 technical papers will cover the currently interesting and important engineering fields. For example there are eight papers on the oil and gas and petrochemical industries; five on mechanical and thermal power projects; one on mining; eleven papers on civil engineering subjects, including two on wintertime construction; five papers dealing with electrical engineering developments; three on chemical engineering; and two aeronautical papers. This program is rounded out by a management panel discussion. The complete list was printed in last month's *Journal*, and in the advance program already received by members.

THIRTY-FIVE YEARS AGO

Comment on the Journal of May, 1922

The world does move. In the May, 1922, *Journal*, A. S. Runciman, A.M.E.I.C., writes, "It is actually possible to set up in homes in Ontario and Quebec a simple receiving set which bring in the concerts from Pittsburgh and New York, not every night, but often during the winter." This quotation is lifted from Mr. Runciman's paper on "High Frequency Telephone as Applied to High Tension Power Lines", an excellent treatise on the fundamentals of radio communication, but rather belying its title, since it mentions the Shawinigan Water and Power Company's system only incidentally, saying ". . . If the weather looks bad at any of the stations, the battery switches are closed and the system is ready for instant use."

The second paper in this *Journal* was a review of current sewage disposal methods read before the Calgary Branch by Dr. C. J. Mackenzie, HON. M.E.I.C., There was nothing startling in it, but it gave a good overall view of the state of the art in 1922. A section is devoted to a description of the "Miles acid process". It is a safe bet that not ten of our readers will ever have heard of it. Of course, such relatively modern steps in the process as elutriation, the separate digestion of sludge and lagooning are not mentioned.

Dr. R. W. Boyle, then Dean of the Faculty of Science at the University of Alberta held forth on "Rainmaking" in this 1922 *Journal*. There was no question then of the efficiency of any method of inducing rain; none tried up to that date had shown any promise, so the author remarks, "It is the earnest wish that some way to induce rain to fall when and where it is wanted, might be reported here, but it is impossible to do so and nobody is known who can." If Dr. Boyle were writing today, he would not be so positive. Rainmaking is now big business, though still regarded as a sort of quack profession by some.

The Institute Committee on Policy was reported as studying "the objects of the Institute, its relation to cognate bodies and its organization under the headings of membership, Council and general, in addition to special matters." The Committee had reached no conclusions it was willing to make public.

The editor of 1922 published a strong appeal to employers in this *Journal*, asking that they should do everything they could to employ engineering students during the summer holidays. Council even passed a resolution to this effect. It appears that jobs were pretty scarce then.

Personals

Personals in this issue of May, 1922 were more than ordinarily interesting. They noted that J. G. Sullivan, president of the Institute, and Col. J. S. Dennis, M.E.I.C., had been asked by the Government of British Columbia to investigate and report on the Pacific Great Eastern Railway, the former on its engineering features and the latter on its economic prospects. This is the railway which for years ended at Squamish north of Vancouver and is now being extended into the city, much to the disgust of residents of the city's residential suburbs on the north shore of Burrard Inlet.

It was also announced that expresident R. A. Ross had been appointed a member of the Royal Commission set up by Ontario to investigate the affairs of its Hydro-Electric Power Commission.

Robert Angus, consulting engineer, of London, Ont., had just been admitted to membership. The fact that he was eighty-one years of age occasioned some *Journal* comment.

Seven members were looking for jobs and there were some vacancies advertised, including sales representatives in the Orient for an agent of a Canadian agricultural machinery manufacturer, with "preliminary expenses (to be borne) by managers in . . . assigned territory," whatever that may mean; a chief traffic officer for the Board of Transport at $6,500 a year and several foresters at $1,680 to $2,000 annually, with a possible $20 per month additional for housing.

The Branches

World War I was still not far from anybody's thoughts. The Victoria Branch had listened to an account of a military survey in Syria, and L. B. Tillson, A.M.E.I.C., had spoken to the Border Cities Branch about "The Work of the Field Artillery". The *Journal* made an odd error in this account. The calibre of the long range gun used by the Germans for the bombardment of Paris was given as "8'-2"! The latter branch was sponsoring the formation of a field company of the Royal Canadian Engineers. The Saint John Branch heard a lecture on underground engineering in France.

The Winnipeg Branch was continuing its interest in the corrosion of underground pipes, especially of those in its own area. The Peterborough Branch was interested in radio and had been listening to broadcasts from Pittsburgh, Schenectady and Newark, but found it "out of the question" to hear a broadcast from Toronto. Before the Ottawa Branch, Dr. J. G. Rutherford, chairman of the Board of Railway Commissioners, characterized the "American invasion of the Northwest" as "sheer exploitation. Land had been deliberately worked out and a yield of thirty-five and forty bushels per acre had been reduced to an average of ten." His concluding remarks might be pondered with profit by all of us, particularly by organized labour, commuters and shippers: "The railways (are) necessary to the country and to the farmer, but they (have) to earn a dividend for the stockholders. The position simply (is) that the people using them (have) to pay for them. It (is) not fair to make others do it."

In 1920 the Saint John Branch and the federal Department of Public Works started a series of tests of the durability of concrete in sea water. No conclusive results had been arrived at in 1922, but certain facts were evident. ". . . During the summer season . . . disintegration (is) not apparent, but with the advent of winter it is rapid and very apparent . . . Blocks of . . . wet consistency . . . disintegrate most rapidly." In 1921, blocks were made of concrete with various admixtures — kerosene, crude oil, pine tar, alum, gypsum, barium chloride, copper acetate, raw sugar, infusorial earth, ochre and sodium silicate. One wonders why some of these additives were chosen and the common ones, like calcium chloride and hydrated lime, omitted. Some of these 1921 blocks were in bad shape in 1922. R DeL.F.

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

QUEBEC

Annual Meeting

The thirty-eighth annual meeting of the 6,200 member-strong Corporation of Professional Engineers of Quebec was held on Saturday, March 23, 1957 at the Sheraton-Mount Royal Hotel, Montreal, under the chairmanship of Leo Roy, 1956-57 president of the organization.

Dr. O. M. Solandt, assistant vice-president, research and development division with the Canadian National Railways, was guest speaker at the dinner, which was followed by the annual dance.

The *Journal* will print a full account of the convention in the June issue.

SASKATCHEWAN

A.P.E.S. Regina Meet

The twenty-seventh Annual Meeting of the Saskatchewan Association convened at the Hotel Saskatchewan in Regina on February 15, 1957 with E. J. Durnin, president acting as chairman. Approximately 125 members were in attendance.

R. Bing-Wo, secretary-treasurer, presented the report of council. It was reported that eight ordinary meetings and one meeting with the board of examiners was held for the transaction of Association business. The secretary reported that one matter agreed upon with the board of examiners was a set of rules of procedure in dealing with applicants having unaccredited academic qualifications. Eleven such cases had been referred to the board for recommendation. The secretary also referred to other council business on engineers and the Trade Union Act to be more fully reported upon by the chairman of the committee concerning temporary licensing, engineers and civil defence, and illegal advertising.

Membership at the end of 1956 totalled 526 profesional engineers.

Dominion Council Report

The report of Dominion Council was presented by Prof. W. R. Staples, Saskatchewan councillor. He reported that uniform registration was again discussed, with British Columbia on one hand, still requiring four years' experience following graduation, and Quebec, requiring none.

Legislation and enforcement was also dealt with. A committee was formed to draft an "Ideal Code of Ethics". Dominion Council had decided to support the Canadian Committee on counselling in Engineering and Science. A motion was passed to make representation to the Dominion Goverment to have professional fees deductible for income tax purposes. A committee was formed to investigate the possibility of setting up a plan of pensions for self-employed engineers. Dominion Council endorsed the National Conference on Engineering Man-Power Shortage. Licensing and reciprocal privileges with U S. engineering bodies was discussed with L. R. Durkee of Seattle, vice-president of the National Society of Professional Engineers in the United States.

The report of the committee investigating engineers and the Trade Union Act was presented by the chairman Prof. W. R. Staples. Briefly summarizing the events up to the previous annual meeting Prof. Staples then reported fully on subsequent developments. A meeting was held on September 7, 1956 with a committee of the Cabinet at which the engineers' case was again presented. One member of the cabinet committee opposed changing the Trade Union Act in any way and proposed that the Association apply to the Labour Relations Board for discertification of professional engineers. The Association Committee felt that this would not be a satisfactory solution. The Union then met with the Cabinet committee on November 28 and presented a counterbrief which the Association felt was very weak. J. T. Douglas arranged a meeting of the Association Committee and the Union Committee for December 18 for further discussion. However the Union had not been in favour of a meeting with the Association committee, but rather with the government engineers presently in the Union. After that meeting, the Association prepared and submitted a further brief in rebuttal to the Union brief. On January 23, 1957, J. T. Douglas officially notified the Association that Cabinet were reticent to amend the Labour Act and suggested a submission to the Labour Relations Board for decertification. Prof. Staples reported that this course of action was now in progress.

Plan for Unity

The committee formed to consider the Plan for Unity reported to the membership in printed form, sent out to all members. This report was prepared under the chairmanship of E. J. Durnin. It discussed in summary form the history of the Plan, basic functions of the proposed national organization, branch activities, membership, fees, affiliated technical societies, a national council, the executive committee, and the present status of the proposal for confederation.

J. McD. Patton commented to the meeting that he was impressed with the large volume of business being handled by Council and various committees, and the efficient, effective action and decisions made. Mr. Patton moved that a vote of thanks be tendered to the president, council, all committee chairmen and members, and the registrar, for their work on behalf of the Association. The meeting concurred with the motion and so indicated by hearty applause.

The election of officers in the Association is as follows: W. G. McKay, Saskatoon, president; J. C. Traynor, Regina, vice-president; K. W. Allcock and M. B. Pierce, of Regina, and B. B. Torchinsky, Saskatoon, councillors; J. Bortolloto, R. V. Tomkins, and D. K. Parkington, chairman, comprise the nominating committee.

ONTARIO

Professional Recognition

Air conditioning, like many other modern conveniences, is now in a stage of advanced development; no matter what the outside temperature may be, the "climate" of offices and homes can be adjusted for maximum comfort and for working conditions which will stimulate maximum efficiency. And just as a healthful temperature, humidity, and circulation of air are conditions for a wholesome climate in a room, professional recognition is one of the conditions under which an invigorating "climate" can be achieved in the relationship between professional engineers and management.

Besides showing management that he

wants professional recognition, the engineer must prove that he merits such recognition, and must work with management to achieve it. The first step in this direction is to be professional, on the job and off the job, all the time; assume responsibilities with the confidence and assertion of a professional; maintain professional standards not only at work but also in the community as a whole.

Double Responsibility

On the job the engineer has a double responsibility, first as an individual and secondly as a team member. The employee-engineer should integrate himself with the firm for which he works. He should be a worthy representative of that organization in business circles and in the management team he should be prepared to serve effectively in any capacity, even though his services may include activities not directly concerned with engineering.

In all professions emphasis is placed upon personal appearance and performance. Imagine a doctor without a gracious bedside manner, or a barrister without a commanding courtroom presence! Without an outward appearance of confidence and a bearing which suggests enthusiasm the professional man is relegated to back rooms and dingy offices. Tackle your job professionally! Discuss it, do it, and report it, professionally.

Continued Study Essential

The man who succeeds is the man who studies; who is continually expanding his interests and keeping in touch with the latest developments both in his profession and in the world about him. It has been estimated that eleven cents of every dollar to be spent three years from now will be for products not yet known to most people. New materials, new techniques and new developments will bring new challenges, new concepts, and new opportunities. So, take advantage of opportunities to learn more about your job, your company, and your profession. Enroll in and support training courses. Take an active part in and contribute to, as well as benefit from, discussions. Prepare yourself to meet the demands which will be made upon you and your profession in the future.

But don't disregard non-engineering subjects. Get to know the other side of the subject and the other fellow's viewpoint. As knowledge broadens, so does the sense of responsibility. When you know what program your firm is planning, see to it that you are part of the program. Make your employer's program your program, and adopt his ambitions as your own.

Responsibility Essential

To share the common task of making your firm succeed in every line of effort, you must be willing to accept administrative or other responsibilities, even though it means that you must turn over your engineering duties to those who are coming along behind you. Don't accept your responsibilities lightly. Remember that management depends on you, and that it may be in reliance upon your findings or your analysis of a situation that huge outlays of time, money and materials may be planned.

As you earn your place in your profession you will find that your importance to your community grows apace. You will be in demand for public services, and the community will look to you for leadership and guidance. How can better leadership be provided than by a man who subscribes to the code of ethics of a professional engineer?

As your stature in the community grows it will enhance your standing in your profession. Thus your social status and your professional standing help each other towards developing you to the full extent of your capacity and your ambition.

You are a professional engineer. Be proud of it and make your status known. Display your certificate of qualification in a prominent place in your office. Declare your membership in technical groups and in your Association. Be proud of your association with fellow professionals. Use the designation "P.Eng." after your name, in signing documents and communications, on letterheads, on business cards, and on the door of your office.

Above all, remember that the broad view is important to full understanding, and that with understanding comes professional stature. As you attain professional stature you are doing your part to create the ideal "climate" in your relationship with management.

Engineers in the News

H. E. McCann, of Phillips Electrical Co. Ltd., Brockville, Ont., has been named assistant to the president of the company, T. A. Lindsay.

Mr. McCann has been with the company since 1944 and has been methods engineer. After obtaining his degree in mechanical engineering from McGill in 1934, he attended M.I.T. and secured a further degree in engineering and business administration. Prior to joining Phillips, he was with Canadian Car & Foundry's Amherst plant and also with stevenson & Kellogg, Toronto management consultants.

I. N. Lobb, has recently obtained his release from the R.C.A.F. and is now employed as an application engineer with the Arthur S. Leitch Co. Ltd., 33 Torbarrie Road, Downsview, Ont., manufacturers and distributors of pumping and heating equipment and engineering specialties.

David R. Smith, city engineer of Woodstock, Ont. since 1953, has retired from that position. Prior to moving to Woodstock, Mr. Smith followed his professsion in New Brunswick and Nova Scotia. From 1937 to 1947 he was director of works and city engineer of St. John, N.B. Prior to becoming city engineer in Woodstock, he was town and public utilities engineer at Bridgewater N.S.

S. E. Geiszczykiewicz, has been granted leave of absence by H. G. Acres & Co. Ltd., of Niagara Falls, Ont., in order to accept an appointment with the United Nations Technical Assistance Administration. In this connection he is proceeding to Karachi, Pakistan, where he will act in an advisory capacity to the Government of Pakistan on Electric Power Development.

Eric H. Holloway, is Industrial Sales Representative of McColl-Frontenac Oil Co. Ltd., Hamilton, Ont. He was previously with Empire Brass Mfg Co. Ltd., of the same city.

G. Otty Machum, has joined Jan H. Reimers, consulting metallurgical engineer, in Toronto. He was formerly employed by the International Nickel Co. of Canada Ltd., at Copper Cliff, Ont.

John Sutherland, is associated with the Warnock Heisey Co. Ltd. as consultant and branch manager of the Ottawa office.

George R. Trewin, has resigned from his position with the Ontario Department of Health and has joined the drainage division of the Metropolitan Toronto Works Department.

Graham P. Kemp, has been engaged as a design mechanical engineer by Dilworth Ewbank, consulting engineers, 4210 Dundas Street W., Toronto 18, Ont. His prior employment was with Wm. Kennedy and Sons Ltd., Owen Sound, Ont.

K. Sumi has returned to the fire research section of the division of building Research, N.R.C., Ottawa, after two years in Great Britain where he completed studies towards his doctorate. His main interest has been the problems of flame suppression and his work was carried out at Imperial College of Science and Technology, University of London. Prior to his return to Canada he had the opportunity of visiting fire research organizations in France, the Netherlands and Germany.

M. L. Vogel who for the past three years has been a lecturer in the heat engines section of the mechanical engineering department of the University of Toronto, has joined the engineering division of the Chrysler Corporation at Detroit, Mich. As a laboratory supervisor at Chrysler, he will organize a new heat transfer laboratory to service research and engineering groups.

Prior to coming to Toronto, Mr. Vogel taught at the University of Wisconsin, directed a research group at A. O. Smith, Milwaukee, and served as industrial engineering consultant for the Government of Israel in Haifa. Mr. Vogel entered Massachusetts Institute of Technology on discharge from the U.S. Army and received his bachelor degree in mechanical engineering in 1947 and his master's degree the following year.

Stephen Kryzevicius, has recently accepted employment with Lazarides, Lount & Partners, Toronto consultants. Previous to this change he was with the Abitibi Power and Paper Co. Ltd., Toronto.

W. A. Carter, has resigned as manager for Area Mines Ltd., and has been appointed general manager for North American Rare Metals Ltd., with offices at 100 Adelaide Street W., Toronto.

Joseph E. Mah, formerly with Toronto Testing Laboratories, has joined the Royal Canadian Mint in Ottawa.

L. W. Swain, has joined E.M.C.O. Ltd., (Empire Brass Co.) London, Ont., as development engineer in charge of engineering. He was previously associated with Babcock-Wilcox & Goldie-McCulloch Ltd., in Galt.

Clarence D. Murdock, has been appointed general manager of Radio Condenser Company Ltd., 6 Bermondsey Road, Toronto 16, according to an announcement of R. E. Cramer, Camden, N.J., president of the company.

Mr. Murdock has been associated with the Radio Condenser Co. Ltd., for the past six years in the capacity of assistant manager. He graduated in electrical engineering from the University of Manitoba in 1932.

C. Alen Geddes has been appointed chief engineer of Bawden Industries Ltd., Toronto.

Mr. Geddes graduated in mechanical engineering after his discharge from service with the R.C.A.F. during World War II. Before joining Bawden Industries, which produces special machinery, he was on the engineering staff of Canadian Westinghouse Co. Ltd., in Hamilton.

F. Tuke has been appointed sales manager of the Auth Electric Co. Inc., of Long Island City, N.Y.

A graduate in electrical engineering of the University of Toronto, Mr. Tuke has had a number of years' experience in the manufacture and sales of signalling equipment in Canada and the United States.

John M. Beattie has moved to South Norwalk, Conn., where he accepted the position of senior design engineer with Remington Rand Univac. Mr. Beattie was formerly with the Canadian Westinghouse Co. Ltd. at Hamilton, Ont.

R. Muirhead has returned to resume his regular work on the engineering staff of Phillips Electrical Co. Ltd., Brockville, Ont., following a period of training in England.

W. C. Ewing has moved to Fort Frances, Ont., from Edmonton, and has been appointed Town Engineer of Fort Frances.

E. Saurazas of Toronto is senior electrical engineer with Catalytic Construction Co. of Canada Ltd., 900 Yonge Street, Toronto. Prior to accepting this post, Mr. Saurazas was with Arthur G. McKee Co. of Canada Ltd. as electrical design engineer.

M. B. Hastings, and **G. F. Dean**, of Toronto have been honoured by the Illuminating Engineering Society.

Mr. Hastings has been elected to the grade of Member Emeritus of the Society of which he is the only Canadian and one of only 37 in with the United States and Canada.

Mr. Dean was elected earlier to the grade of Fellow, of which four others hold similar membership in Canada.

W. Gordon Wilson of the National Sewer Pipe Co. Ltd., Toronto, has been named production manager of the company. In this capacity he is responsible for production at the company's vitrified clay pipe plants at Clarkson, Hamilton and Swansea, and the plain end pipe coupling plant. Also under his supervision is the concrete pipe plant at National Concrete Products Ltd., Mimico.

BRITISH COLUMBIA

Certificate No. 3000

Presentation of registration certificate No. 3,000 to Wilfred Pegusch, highlighted the Association of Professional Engineers of B.C.'s annual dinner for the graduating class of engineers from U.B.C.

Col. W. G. Swan, O.B.E., D.S.O. made the special presentation. Col. Swan, who was the first elected president of the Association (1921) is also head of Swan, Wooster & Partners, consulting engineers, where Mr. Pegusch practices.

U.B.C. Professor Emeritus J. M. Turnbull, holder of registration certificate No. 5 was also present and added his congratulations to Mr. Pegusch.

Inter-Club Competition

Another feature of the evening was the first annual inter-club competition between members of Beaver (engineers) Toastmasters Clubs from Vancouver, Victoria and Britannia Beach. The Association trophy was awarded to **H. D. Currey**, of Vancouver, who won out over **A. R. D. Robertson**, of Victoria by the narrowest of margins. **G. C. Lipsey**, representing the newly-formed Britannia Beach Club, brought greetings and a message from his club that they would be very much in the running for the trophy next year.

Four professional engineers were presented with Life Membership medallions at the meeting by President W. O. Richmond. They were **A. G. Graham**, Vancouver, **D. A. Spalding**, Haney, **E. F. Cooke**, Sechelt, and **T. E. Price**, Vancouver.

Engineers in the News

W. E. Atamanchuk, of the Richmond Exploration Company has moved from Caracas to Maracaibo, Venezuela.

R. Battistella has been promoted from chief electrical engineer to chief design engineer at the City of Edmonton power plant.

S. D. Cavers is now associate professor of chemical engineering at the University of British Columbia. He was formerly with the B.C. Research Council as a research engineer. He was associate professor of chemical engineering at the University of Saskatchewan in 1952.

Lawrence D. Smillie has moved from the North West Territories some time ago and now holds a position as mill superintendent of the Iron Benefication plant at Texada Mines Limited, Gillies Bay, B.C.

E. J. Huckson of New Zealand has joined the field staff of Dominion Construction Limited at Port Alberni, working on the MacMillan and Bloedel Pulp plant extension project.

David Liberson has taken up engineering duties with the B.C. Electric Company Ltd.

K. R. Main, recently arrived from Great Britain, has taken up a civil engineering appointment with Lafarge Cement of North America Limited.

H. R. Shawk has been acting as consultant to the National Government of China.

J. Dan McGuire has joined the staff of Conveyair Limited, North Vancouver.

ALBERTA

Annual Meeting

The thirty-seventh Annual General Convention of the Association of Professional Engineers of Alberta was held at the Palliser Hotel, Calgary on March 29 and 30. Special speakers were the Right Honourable C. D. Howe, minister of Trade and Commerce, and Dr. N. H. Grace, director of research for the Research Council of Alberta at Edmonton. Dr. Grace addressed the luncheon meeting.

A full report of the two-day affair will be carried in the June issue of the *Journal*.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Air Vice-Marshal E. W. Stedman, C.B.E., M.E.I.C., retired director general of research with the R.C.A.F., died on March 27, 1957, at Ottawa.

Born at Malling, Kent on July 21, 1888, he received his primary education at Maidstone, Kent. This was followed by four years at a combined workshop and technical school, where he won the Whitworth Medal and a free studentship providing entrance to the Royal College of Science, London.

Three years later he secured a first class associateship in mechanics, the Bayliss prize for the highest standing in the qualifying examination for Associate members of the Institution of civil Engineers, and a Whitworth scholarship.

Another year of study in civil and mechanical engineering followed, at the City Guilds College, London, and during that period the future Air Vice-Marshal was associated with the artillery as a member of the University of London Officers Training Corps.

He began his graduate career as a draughtsman in a Southampton firm. In 1913 he received the appointment of scientific assistant in aeronautics at the National Physical Laboratory, Teddington.

Commissioned a lieutenant on the outbreak of World War I, he joined the Royal Naval Volunteer Reserve, attached to the Royal Naval Air Service. Later, when the Royal Air Force came into being in 1918, he became a major. The following month brought a promotion to the rank of lieutenant-colonel and in addition, the O.B.E.

On demobilization from the R.A.F. in 1919 he was appointed chief to the technical staff in the aircraft firm of Handley Page, Limited, London.

In May 1919 he went to Newfoundland to take charge of the entry by that firm for the £10,000 prize put up by the Daily Mail for the first transatlantic flight by a heavier than air aircraft. Alcock and Brown succeeded in taking off first, however, and won the prize and much distinction. Shortly after the creation of the Air Board, Air Vice-Marshal Stedman came to Canada to take charge of the technical directorate responsible for stores, supplies and contracts. In 1921 he joined the Canadian Air Force and on its formation in April 1924 became a member of the R.C.A.F., rising steadily in the service as chief aeronautical engineer.

Among his most notable exploits was a flight across the Atlantic as representative of the R.C.A.F. in August 1930 in H.M. Airship R-100. The journey commenced at St. Hubert Airport, Montreal and was concluded fifty-seven hours later at Cardington, Eng. On his retirement from the R.C.A.F. in 1945 he represented the Canadian Government at the Bikini atomic test in 1946.

He became professor of mechanical engineering at Carleton College, Ottawa, in 1946, remaining there until 1955.

He was, during the last few years engaged in the preparation of a history of aviation in Canada, under the auspices of the Canadian Government. He was also a member of a government appointed committee establishing the present plan of officer training for all three services.

A/V/M E. W. Stedman, C.B.E., M.E.I.C.

Air Vice-Marshall Stedman was a Member of the Institution of Civil Engineers, the Institute of Metals and the Canadian Advisory Committee of the Institution of Civil Engineers. He was a Governor of the Royal Aeronautical Society and of the Institute of Aeronautical Sciences. He was an Honorary Fellow of the Canadian Aeronautical Institute. He held the chairmanship of the Associate Committee of Aeronautical Research of the National Research Council, in 1935.

A winner of the Julian C. Smith award of the Engineering Institute, he also held the Daniel Guggenheim Medal.

In 1947 the United States honoured him with the award, Commander of the Legion of Merit.

Air Vice-Marshal Stedman joined the Engineering Institute as a Member in 1921. He was in 1934 elected chairman of the Ottawa Branch of the E.I.C., and the following year sat on the Council of the Institute. He attained Life Membership in January, 1957.

Matthew Balls, M.E.I.C., retired assistant vice-president of the Shawinigan Water and Power Company, and manager of the company's hydraulic resources department died at Sweetsburg, Que., on February 12, 1957.

Mr. Balls was born at Ryton-on-Tyne, Eng., on October 8, 1887 and had his education in that country. Moving to Canada in 1906 he was employed with the Spokane, Portland and Seattle Railway as a chainman and rodman on location survey.

He was later employed with railways in Alaska, B.C., Idaho and Washington.

Appointed assistant engineer with the Dominion Government Hydrometric survey in 1915 Mr. Balls was the following year named hydraulic engineer with the Dominion Department of the Interior, and spent the next ten years in irrigation and water power surveys in B.C. and the Yukon.

Mr. Balls joined the staff of Shawinigan Water and Power Company in 1926. He was named manager of the water resources department in 1941. He became assistant vice-president in 1948. On his retirement in 1954 he also held the post of manager of the hydraulic resources department.

He was for several years a member of the National Research Council's subcommittee on ice and snow research.

He became a director of the St. Maurice Power Corporation in 1945 and its secretary in 1950.

Mr. Ball joined the Institute in 1910 as an Associate Member, transferred to Member in 1940 and attained Life Membership in 1954.

Thomas Leo Hughson, M.E.I.C., civil engineer with the Department of Veteran's Affairs at Ottawa, died in that city on February 18, 1957.

Born at Niagara Falls, Ont., on January 26, 1891, he had his education there and graduated at Queen's University in 1916. In 1917 he enlisted with the R.C.E. and served overseas until 1919. Returning to Canada at that time he became associated with the Hydro-Electric Power Commission, Ontario power development, in the construction department and worked with several construction companies in the United States and took part in the erection of the Detroit-Windsor tunnel. Also at about that time he became vice-president of Robertson Construction and Engineering Company Limited at Niagara Falls. In 1930 he travelled to Russia as a representative for the Albert McKee Company of Cleveland, Ohio. On his return to Canada in 1932 he had experience on the Trans-Canada highway and was again associated with the A. B. Robertson Construction and Engineering Company at Niagara Falls.

Moving to Ottawa in 1946 to take over the position of district superintendent of buildings with the Department of Veteran's Affairs he remained there until the time of his death. In 1947 he was promoted to regional engineer.

Mr. Hughson joined the Institute in 1919 as an Associate Member and was transferred to Member in 1940.

Personals

News of the Personal Activities of Members of the Institute.

Dr. R. E. Heartz, M.E.I.C., past-president of the Institute and president of the Shawinigan Engineering Company Limited has been elected to the board of directors of the Shawinigan Water and Power Company.

Dr. Heartz is a member of the board of governors of Sir George Williams College in Montreal; the board of regents of Mount Allison University at Sackville, N.B., where he received an honourary doctorate of laws in 1952; and the board of governors of the Royal Edward Laurentian Hospital, Montreal.

Dr. Heartz is a past-chairman of the Montreal Branch of the Institute, has also served as a councillor and in 1949 was elected vice-president of the Institute for the Province of Quebec.

Dr. R. S. Jane, M.E.I.C., president of Shawinigan Chemicals Limited, has been elected to the board of directors of the Shawinigan Water and Power Company.

Dr. Jane is also a director and vice-president of Canadian Resins and Chemicals Limited, a director of B. A. Shawinigan Limited, Montreal and of Shawinigan Resins Corporation, Springfield, Mass.

Bruce B. Shier, M.E.I.C., has been appointed marketing manager of Automatic Electric Sales (Canada) Limited.

Mr. Shier is a graduate in electrical engineering from McGill University, class of 1923. After several years' experience in the inspection engineering and field surveys of communication equipment, he joined the staff of Automatic Electric in 1935 as sales engineer. Since 1947 he has been in charge of the sales promotion of all products handled by the company.

B. B. Shier, M.E.I.C.

C. K. McLeod, M.E.I.C., of Montreal, recently elected to the board of directors of the Permutit Company of Canada has now been elected vice-chairman of the board.

He was earlier this year elected president of Walter Kidde and Company of Canada Limited.

Mr. McLeod is also a past vice-president of the Institute.

Dr. R. L. Hearn, M.E.I.C., has been elected to the board of directors of Humphreys and Glasgow (Canada) Limited, Toronto, a recently established subsidiary of Humphreys and Glasgow Limited, London, Eng.

Until recently chairman of the Hydro-Electric Power Commission of Ontario, Dr. Hearn is still active as a consultant to the organization.

On many occasions openly acclaimed for his contribution to Ontario's publicly owned hydro enterprise and the Canadian engineering field, he was given lasting recognition in 1951 when Canada's largest fuel-electric power plant, the Richard L. Hearn Generating Station was named in his honour.

In the period of more than forty years since first joining the commission, Dr. Hearn has played a major part in the growth of the organization, with its unprecedented power expansion program, embracing major hydro-electric projects and Canada's largest steam generating installations.

J. G. Hall, M.E.I.C.

H. W. L. Doane, M.E.I.C.

John G. Hall, M.E.I.C., who retired from the Combustion Engineering Corporation, Toronto, as district manager in 1956, has been appointed executive vice-president with the Bituminous Coal Institute of Canada. Affiliated with the Canadian Commercial Coal Dock Operators Association, an extensive program of research and marketing projects, similar to one conducted by engineers of the Bituminous Coal Institute in the United States is being planned under Mr. Hall's direction.

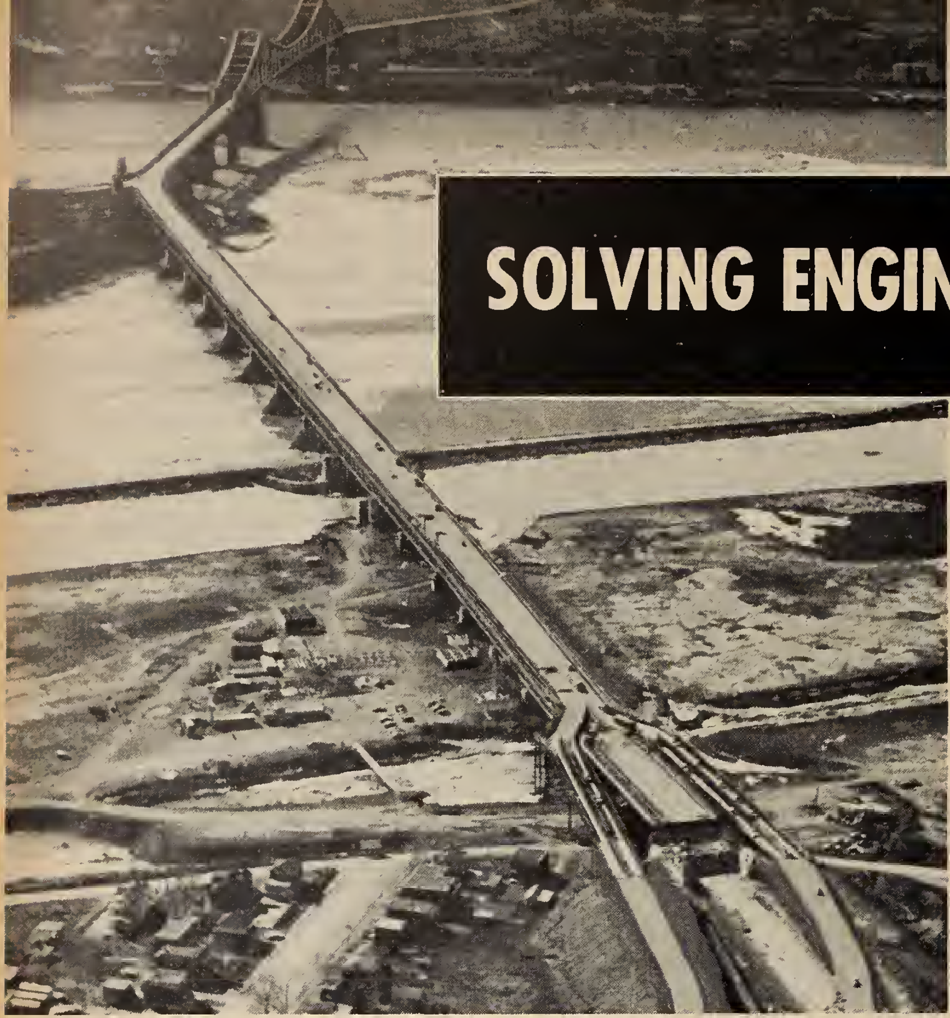
Under the plan Mr. Hall will also be available for consultation with architects and consulting engineers planning major industrial projects.

He is a member of the American Society of Mechanical Engineers and is an Associate Member of the Institute of Power Engineers.

Mr. Hall is a past chairman of the Toronto Branch of the E.I.C. He served on the council of the Institute in 1940-42.

H. W. L. Doane, M.E.I.C., of Halifax, vice-president of the Institute, manager and director of Standard Paving (Maritime) Limited, has been awarded an honourary Doctor of Engineering degree at the annual convocation of the Nova Scotia Technical College on May 8, 1957.

Mr. Doane was educated in the Halifax public schools, Dalhousie University, and the Nova Scotia Technical College, receiving his B.Sc. in civil engineering from the latter institution in May 1913.



SOLVING ENGINEERING PROBLE

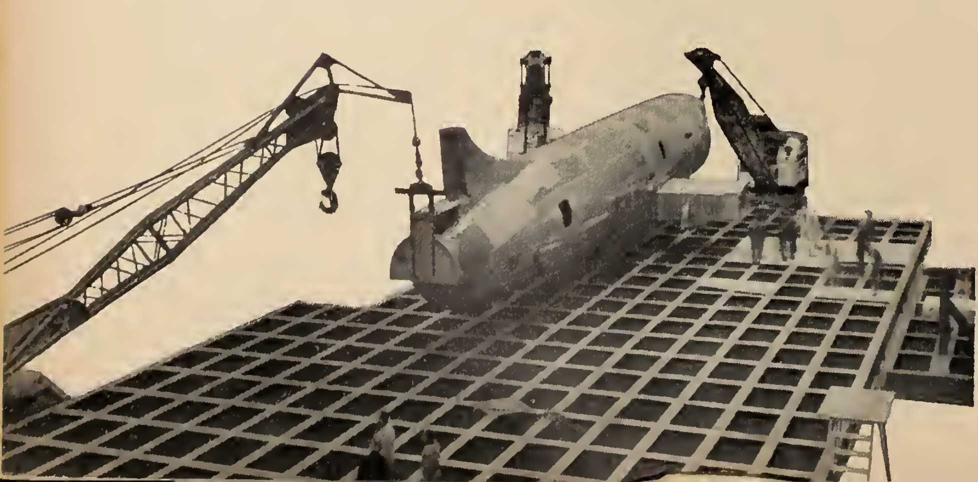
UNIQUE SEAWAY PROJECT

One of the early operations in raising the Jacques Cartier Bridge, Montreal. At this stage traffic has been diverted to permit the raising of the South approach and uninterrupted traffic will be maintained over the bridge during the construction period. Seven other major seaway contracts have also been awarded to Dominion Bridge.

Expansion brings diversified engineering problems—as these recent examples.

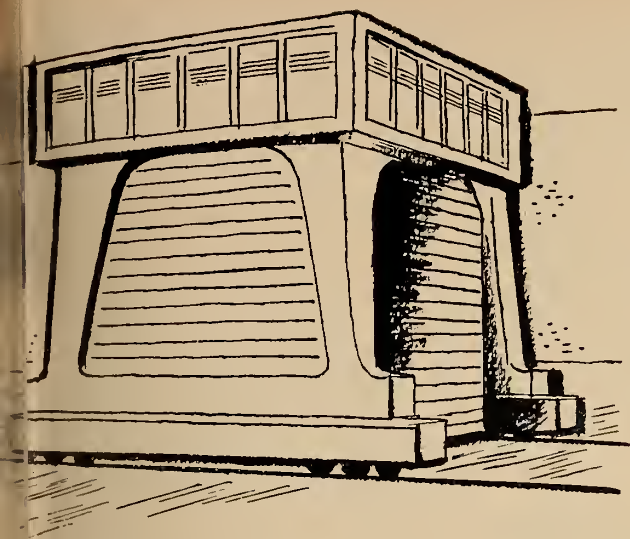
In every province and in every major industry, Dominion Bridge gineers are making important contributions to Canada's phenomer growth.

To help Canada's expansion Dominion Bridge last year announced own four year expansion programme. Now in full swing—this will ha the effect of increasing the Company's overall capacity by 40 per cent a will assure even better service to our customers from coast to coast.



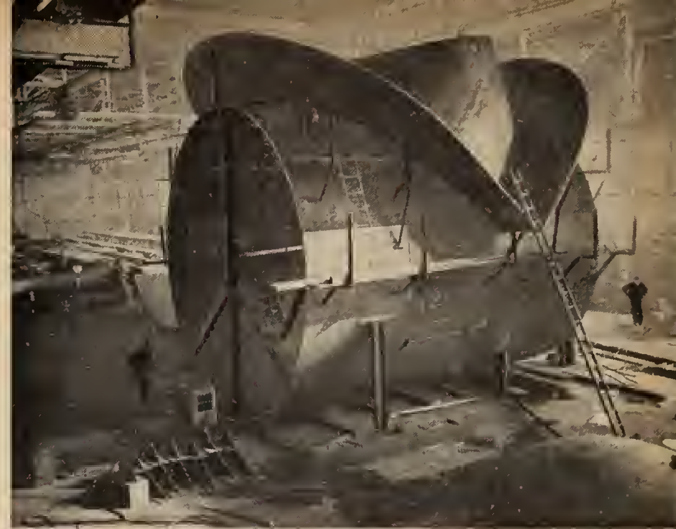
TEST BED FOR CANADA'S LARGEST AIRCRAFT:

To avoid distortion during fitting and ing of this massive steel grid, for Can Ltd., special field welding procedures devised by Dominion Bridge engineer



MDERN TREND IN CRANES:

Th 300-ton gantry crane, the largest ever built in Canada, wa designed and fabricated by Dominion Bridge for the Cadian half of the St. Lawrence Power Project. Completely nosed, it illustrates a modern trend in design.

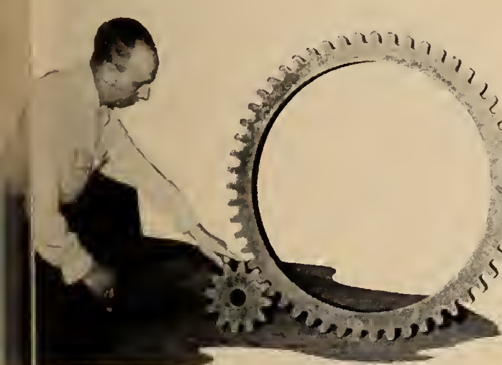


22′ diam. T SECTION FOR POWER PROJECT:

One of many large platework components recently built by Dominion Bridge for the Ladore Falls Power Development, B.C. Other items included Y sections, penstocks and scroll cases.

MODERN TREND IN BOILERS:

Newly developed Dominion Bridge water tube package unit boiler. Units such as this are shop assembled and shipped complete to the site ready for connecting to steam, oil and water lines.



FLME CUT GEARS:

Ou steel warehouse division frequently ssts other manufacturers in solving the own engineering problems. This pa of gears, 2½″ in thickness, was recntly supplied in less than a day for a r h order.

"SEEL FOR URANIUM":

Thusands of tons of structural steelwork ha been fabricated and erected by Dminion Bridge for Canada's huge uraium developments. One example is Algm Uranium's Nordic Mill, near Blid River.

DO INION BRIDGE COMPANY, LTD.

DOMINION BRIDGE

• PERSONALS

Following graduation Mr. Doane practised as a consulting engineer, until his enlistment in the Canadian Artillery during World War I. He returned to Halifax with the rank of major in 1919 following extensive service overseas.

In 1919 Mr. Doane was appointed assistant city engineer for Halifax, which position he occupied until 1928 when he became manager of Argyle Motor Services. Three years later he undertook the management of Standard Paving Maritime Ltd., of which he is now manager and director.

During 1944-47 he was manager of the Halifax Utilities Commission.

Mr. Doane is a former chairman of the Halifax Branch of the Institute. He served the council of the Institute in the 1925, 1945 and 1951 terms of office.

K. O. Elderkin, M.E.I.C., has been elected a director of Bowater Corporation of North America Limited.

Mr. Elderkin is president of Bowaters Research and Development Incorporated, of Calhoun, Tennessee. This company has recently been formed to co-ordinate development and production for all units of the Bowater organization in North America.

Mr. Elderkin is one of the leading paper experts in North America. Until his appointment to head the research and development company he was vice-president and general manager of Bowaters Southern Paper Corporation at Calhoun.

He is a graduate of McGill University. Mr. Elderkin is president of the Technical Association of the Pulp and Paper Industry.

Fernand Dugal, M.E.I.C., who was a few months ago named chief engineer, shops and transportation with Quebec Hydro, has joined Sorel Industries Limited as works manager.

Mr. Dugal, a graduate of McGill University, class of 1939 in mechanical engineering, began his career with the Canadian Car and Foundry Company, Montreal, served with the R.A.F. as a technical officer during world War II, at Dorval, Que., and in 1944 joined Cartier Industries, Montreal as a consulting engineer and works manager. The following year plant engineer with the Montreal Locomotive Tank Arsenal he transferred to the American Locomotive Company at Schenectady, N.Y. as a plant engineer in 1946. He became associated with Hydro-Quebec in 1949 when he was engaged as an assistant chief engineer of shops and transportation.

J. W. Ross, M.E.I.C., has been promoted to the position of assistant manager, development, of the Linde Air Products Company, division of Union Carbide Canada Limited.

Prior to his new assignment as assistant manager of engineering he was also a short time ago appointed operations manager of the electric products department of the firm. Mr. Ross will be located at the Linde General offices at Toronto and will be engaged in the development of new products and processes and their application to industry.

Mr. Ross graduated from the University of Toronto in 1941 with a B.A.Sc. degree in mechanical engineering and has been associated with the firm for twelve years.

Gerald G. Fisch, M.E.I.C., has been named a vice-president of Bruce Payne and Associates, Inc., management consultants. Mr. Fisch who joined the company in 1955 and became an assignment director in 1956, was formerly with Canada Packers, Ltd., and also served as vice-president and general manager of a leading consulting firm in Canada.

A graduate of McGill University, Mr. Fisch has degrees in management and engineering from the Massachusetts Institute of Technology gained in 1950.

In his new position Mr. Fisch will maintain headquarters in the firm's New York office and will also be concerned with company activities in several American and Canadian cities.

• PERSONALS

Harry G. Stead, M.E.I.C., has for a number of months held an appointment as manager with the Winnipeg firm of Betts-Eastman at their Simcoe, Ont. processing plant. Betts-Eastman specialize in the field of hydraulics.

Mr. Stead was, prior to joining the company president and chief engineer and latterly general manager with E. Leonard and Sons Limited, London, Ont. He joined the organization in 1923.

Mr. Stead is also a past-chairman of the London Branch of the Institute.

John E. Bright, M.E.I.C., formerly district engineer with the Department of Public Works, Canada, at Halifax, has assumed the position of chief of the maintenance and operations division.

Mr. Bright joined the Department of Public Works as an engineer in the London, Ont., district office in 1946, on his return to Canada after several years overseas with the Royal Canadian Engineers. Transferred to headquarters in Ottawa in 1953 he was employed first in the bridge design section and then in the structures division of the development engineering branch. The following year he was moved to the Harbours and Rivers Engineering Branch and worked in the Atlantic section until his appointment as district engineer in 1955.

He is a 1938 graduate of Queen's University, Kingston, with a bachelor of science degree in mechanical engineering.

Charles K. Hurst, M.E.I.C., has been appointed chief of the Marine Excavation Division, Department of Public Works, Canada, following service with the Department of Northern Affairs and National Resources as hydraulics engineer, hydraulics division, Water Resources Branch.

Mr. Hurst is a 1937 graduate of the University of Alberta in civil engineering. He obtained an M.Sc. degree in hydraulic engineering at the University of Iowa in 1940. The following year employed with the City of Edmonton as a hydraulics engineer he also became associated with the Department of Transport, Canal Services, as a junior hydrometric engineer before joining the Royal Canadian Navy.

Returning to the Canal Services of the Department of Transport in 1945 following overseas service he has since then worked with the general engineering branch of the department, with the Peterborough office of Canal Services, as assistant superintending engineer. In 1952 he was appointed engineer adviser to General A. G. L. McNaughton, chairman of the Canadian Section of the International Joint Commission. In March, 1955 he became chief of the International Waterways Section, Water Resources Branch of the Department of Northern Affairs and National Resources.

• PERSONALS

James A. Brown, M.E.I.C., who has for the past seven years been manager of the Toronto Branch of the Dominion Welding Engineering Company Limited has been transferred to the Montreal head office as assistant general manager. Following graduation from Queen's University in mechanical engineering, in 1944, Mr. Brown joined the R.C.N.V.R. He transferred later from marine engineering to the Fleet Air Arm, attended the Royal Naval Engineering College in England and served with the Royal Navy.

Returning to Canada at the end of the war he joined the Spruce Falls Power and Paper Company at Kapuskasing as a design engineer and was later appointed special expeditor at head office in Toronto.

He also held positions with the Ford Motor Company and the International Nickel Company.

J. G. Lefebvre, M.E.I.C., formerly technical staff officer, grade two, holding the rank of major with the Canadian Joint Staff, London, Eng., recently obtained release from the Canadian Army in order to accept the position of general manager of the firm of Aero Mechanic Limited at Quebec, Que.

Now a member of the reserve army, he has affected to the 8 Militia Group Headquarters.

While on active military service Mr. Lefebvre was with the Defence Research Board as head of the design section at the Canadian Armament Research and Development Establishment. Later he was posted to the Armament Design Establishment, which is a branch of the United Kingdom Ministry of Supply.

He is a 1948 graduate in mechanical engineering from McGill University.

Vassyl Nakonechny, M.E.I.C., formerly an estimator in the industrial drawing office with Canadian Vickers Limited, Montreal, has accepted an appointment in Washington, D.C. Mr. Nakonechny is employed as a naval architect with the David Taylor Model Basin.

He is originally from Belgium where he studied at the University of Louvain.

W. Rothwell, M.E.I.C. production manager with TCF of Canada Limited, has been elected chairman of the Cornwall Branch of the Institute for the 1957-58 season.

Mr. Rothwell, who came to this country from England in 1947 has since that time held appointments with Montreal Cottons Ltd., at Valleyfield, Que., and with TCF of Canada Ltd., in 1952 on the building of a new plant in Cornwall for the manufacture of transparent cellulose film. He was named to his present position in 1955.

A graduate of London University, class of 1938, he served as part-time lecturer in mechanical engineering at the

• PERSONALS

Bradford Technical College and the Carlisle Technical College until 1942, as well as being associated with Vantona Textiles Ltd., Manchester, and the Bradford Dyers Association Ltd., as chief engineer of the Bowling Dyeworks, Bradford, Yorks.

In 1942 volunteering for military service he was until the war's end a member of the Royal Electrical and Mechanical Engineers. Released from military duties in 1945 he returned to the Bradford Dyers Association and received the appointment of chief engineer of the subsidiary Egyptian company called Beida Dyers S.A.E., at Alexandria where he was responsible for all engineering activity including the building of an additional new plant.

In 1947 he returned to England and was appointed works engineer with Ferguson Brothers at Carlisle. It was shortly after this that he came to Canada.

W. Rothwell, M.E.I.C.

W. H. Ackhurst, M.E.I.C.

W. H. Ackhurst, M.E.I.C., manager of sales, motor and control department with the Canadian General Electric Company Limited at Peterborough, Ont., has been elected chairman of the Peterborough Branch of the Institute.

A graduate in electrical engineering from the Nova Scotia Technical College, class of 1939, Mr. Ackhurst has been associated with the company for some time.

He joined the firm prior to enlisting in the R.C.E.M.E. during World War II and returned to the organization in 1946.

J. C. Savage, M.E.I.C., has for a number of months held the position of assistant to the general superintendent, the Aluminum Company of Canada Limited, chemical division, at Arvida, Que.

Mr. Savage recently spent a year in Europe at the Centre d'Etudes Industrielles, the international school of business administration founded by the company at Geneva.

He is a McGill University graduate, class of 1948, and was formerly assistant superintendent of the Bayer Ore plants at Arvida.

significant advance in rail POWER for industry and switching

DIESEL HYDRAULIC LOCOMOTIVES OFFER

smooth power - operating economy - easy maintenance

Diesel Hydraulic locomotives use exactly the same principle of power transference to the driving wheels, as does the automatic transmission of a motor car. Since there is no rigid connection between engine and wheels, possible damage to the transmission or engine due to coupling, is eliminated.

Specialized Facilities and Personnel are not required to service and maintain Diesel Hydraulic Drive Locomotives. Due to the absence of electrical rotating equipment, it is not necessary to maintain stocks of spare renewal parts such as, brushes, relay contacts etc.

Diesel Hydraulic Locomotives are built in the following sizes:

12 — 15 tons	20 — 25 tons
30 — 35 tons	40 tons
44 tons	50 — 65 tons

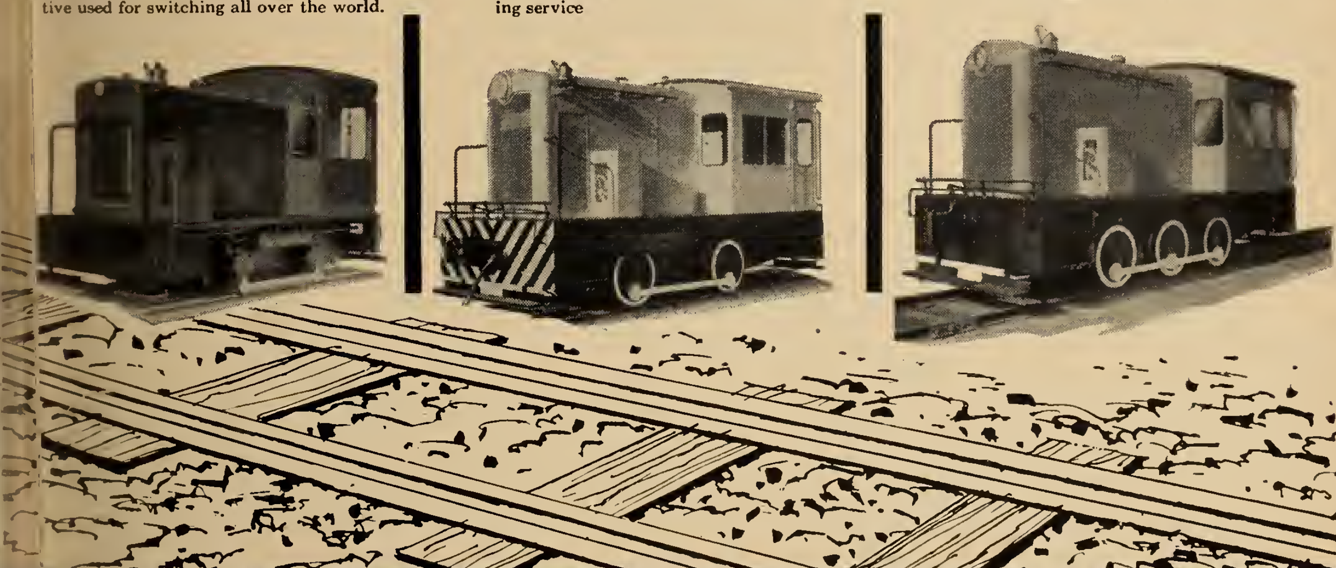
CLC also build:

Diesel Mechanical
Steam and Steam Fireless and
Diesel Electric Locomotives

15 ton, 0-4-0 Diesel Hydraulic switching locomotive—typical of the class of locomotive used for switching all over the world.

40 ton, 0-4-0, 300 h.p. Diesel Hydraulic locomotive for medium duty switching service

40 ton, 0-6-0, 300 h.p. Diesel Hydraulic switching locomotive.



SALES OFFICES:

85 Richmond St. W., Toronto, Ont.

Head Office: Kingston, Ont.
140 Ontario St., Kingston, Ont.

980 St. Antoine St., Montreal, P.Q.

FABRICATION IN STEEL, STAINLESS STEEL, AND ALUMINUM TO CUSTOMER SPECIFICATIONS

• PERSONALS

R. W. J. Moore, JR.E.I.C., a 1954 graduate of the University of Toronto in civil engineering has been named city engineer at Woodstock, Ont.

He has, since his graduation held the post of assistant city engineer of that community.

James Q. Calkin, JR.E.I.C., who has been in Great Britain for the past two and a half years has returned to Canada. He is with Avro Aircraft Limited, Malton, Ont., as a design engineer in the initial projects office.

Originally employed with Avro Aircraft Limited as an engineer in training, following his graduation from the University of New Brunswick in 1953, he was in 1954 awarded a Cranfield scholarship for two years post-graduate study at the College of Aeronautics, Cranfield, Eng. Specializing in aircraft design he was awarded the diploma of the College of Aeronautics (D.C. Ae.) on completion of the course last year.

He then accepted a position with A. V. Roe and Company, Manchester, Eng., as a design technician in the project development department and remained there until early this year.

Mr. Calkin graduated from the University of New Brunswick in 1953.

B. C. Halley, JR.E.I.C., who graduated from the University of London, class of 1948, with a B.Sc. degree in civil engineering now resides at Kingston, Jamaica. He is at work as an assistant civil engineering superintendent on the construction of an aluminum plant for Alcan.

D. G. Couroubakilis, JR.E.I.C., a 1953 graduate of the University of British Columbia has been appointed structures engineer with the Sudan government, ministry of irrigation and hydro-electric power, known as the Managil Scheme at Wad-Medani.

Mr. Couroubakilis went to the Sudan shortly after his graduation and worked as an irrigation engineer on the White Nile Pumping Scheme and the Zuleit Pumping Scheme, located at Kesti.

R. E. Moore, M.E.I.C., formerly of the Department of Mines and Technical Surveys at Ottawa has left Canada and will be resident in the Netherlands for a period of one year, where he will be located at the International Training Centre for Aerial Survey at Delft.

Mr. Moore was a 1949 graduate of the Nova Scotia Technical College and holds a B. Eng. degree in civil engineering.

Pierre La Rochelle, JR.E.I.C., a Laval University graduate in civil engineering, class of 1954, is in London, England, studying under an Athlone Fellowship.

Mr. La Rochelle carried out two years' research on frost action in soils, following his graduation. Through the Fellowship he is now specializing in soil mechanics under Professor Skempton, at the Imperial College of Science and Technology, at London.

J. I. B. Williamson, JR.E.I.C., for a number of years an officer with the Royal Canadian Engineers, is now employed with Canadian Fairbanks-Morse Company Limited, engine and pump and electrical division at head office, Montreal.

On graduation from the Royal Military College in civil engineering in 1952, commissioned as a lieutenant, he served in Korea as a troop and reconnaissance officer. He was engaged in planning and executing road building, in maintenance projects, tunnelling and field defence works, and mine welfare.

In 1954, awarded a B. Eng. degree in civil engineering at McGill University, he later embarked on a long

• PERSONALS

survey course in England and followed instruction on the techniques and organization of survey and mapping.

He was appointed to the Army survey establishment at Ottawa and was during the summer of 1955 given command of a field mapping operation in the Arctic.

John K. Abel, JR.E.I.C., who has for some time held the position of chief engineer in the Automotive Manufacturing Division of Thompson Products Limited, St. Catharines, Ont., has been promoted to manager of the replacement division of the firm.

Mr. Abel began his professional career with the Canadian Comstock Company Limited. He is a 1947 graduate of McGill University in mechanical engineering.

J. J. Hamilton, JR.E.I.C., a 1955 graduate of the University of Manitoba, who obtained an M.Sc. degree in soil mechanics and hydraulics at the University of Manitoba the following year, is working with the National Research Council, Ottawa.

Employed with the division of building research, soil mechanics section, his work is in conjunction with the cooperative research project being carried out with the St. Lawrence Seaway authority on special soil mechanics problems.

W. A. Neale, JR.E.I.C., has been appointed manager of the Toronto Branch of Dominion Welding Engineering Company Limited.

Following graduation from the University of Toronto in mechanical engineering in 1946 Mr. Neale served with the R.C.E.M.E. and until recently was chief engineer and general manager of E. B. Magee in Port Colborne, Ont.

J. B. Bowron, JR.E.I.C., has been appointed gas turbine sales engineer in Western Canada by the English Electric Company of Canada Limited with headquarters at Calgary.

A University of Alberta graduate in electrical engineering, class of 1950, Mr. Bowron has recently returned from England, where he was with the English Electric Company Limited in their gas turbine department at Whetstone. His experience in England included the erection, testing and sales of gas turbines.

Richard A. Sara, JR.E.I.C., of the Taylor Instrument Company, has been transferred from Toronto to their Los Angeles office. He continues to work as a sales engineer.

Mr. Sara is a graduate of the University of Manitoba in mechanical engineering, class of 1949.

W. A. Godfrey, JR.E.I.C., a 1954 graduate of the University of Manitoba, in electrical engineering is employed with the Bell Telephone Company of

• PERSONALS

Canada, Montreal as an engineer engaged in work on the Trans-Canada microwave relay system.

Mr. Godfrey returned to Canada a few months ago after spending two years in England under an Athlone Fellowship. While in England he was engaged in post-graduate work in radar development with a large electrical manufacturing firm in Rugby.

E. J. Lockwood, JR.E.I.C., has accepted an appointment as district engineer with the Trans Mountain Oil Pipe Line Company whose offices are located at Kamloops, B.C., and is responsible for engineering work carried out in the area.

Previously with the British Columbia Forest Products Limited, Hammond Sawmill division, he was for more than five years employed as plant engineer.

Mr. Lockwood is a 1950 graduate of the University of British Columbia, with a bachelor of applied science degree in mechanical engineering.

Captain J. J. Eatock, JR.E.I.C., has moved from Edmonton, Alta., to the office of the chief eingineer at Army headquarters, Ottawa. Captain Eatock previously held the appointment of officer commanding, the N.W.T. and Yukon Detachment of the R.C.E.

He was previously stationed in Eastern Canada with the Fifty-eighth Independent field squadron of the R.C.E. at Montreal in 1952. Captain Eatock is a University of Alberta graduate, class of 1949, in chemical engineering.

G. T. Fenwick, JR.E.I.C., has for several months held the appointment of chief engineer with the London, Ont, firm of Unifin Tube Company Lmiited.

A University of Saskatchewan graduate in mechanical engineering class of 1952, he was previously employed with the Canadian Westinghouse Company Limited, Hamilton, Ont.

O. Schavo, JR.E.I.C., formerly of Montreal has gone to London, Ont., where he is employed with the Minnesota Mining and Manufacturing Company as a mechanical engineer.

He was previously employed with Northern Electric Company Limited.

Mr. Schavo is a 1954 graduate of the University of Toronto.

G. R. Walker, JR.E.I.C., has joined the staff of the Ontario Hydro-Electric Commission, research division at Toronto.

He is a University of New Brunswick graduate class of 1954 and was last year engaged as a field engineer with the Foundation Company of Canada Limited at Chalk River, Ont.

W. G. McGaughey, JR.E.I.C., has been transferred from Montreal to Toronto with the Foundation Engineering Corporation Limited.

He is a Queen's University graduate in electrical engineering, class of 1952 and began his engineering career with the Canadian General Electric Company at Toronto.

R. W. Lockie, JR.E.I.C., has accepted an appointment with the B.C. Power Commission, mechanical engineering department, power development division in Victoria, BC.

Formerly with the English Electric Company of Canada Limited, at Toronto, he was employed in the hydraulic department of the firm.

Mr. Lockie is a graduate of the University of British Columbia, class of 1950.

T. L. Salmon, JR.E.I.C., of the British American Oil Refinery has been transferred from Toronto to the Regina, Sask, office.

Mr. Salmon has been with the company for some time.

He graduated in mechanical engineering from the University of Saskatchewan in 1949.

NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

BELLEVILLE

E. T. HILBIG, JR.E.I.C.,
Secretary-Treasurer

General Meeting

D. C. Warren of the Canada Metal Co., Toronto, delivered a most interesting talk on the most modern method of producing precision castings as for bearings. In his talk he mentioned that the process of casting cylindrical shapes centrifugally had been developed by the Schwietzke Company of Dusseldorf, Germany and that his company had actually obtained this technique from the German Company.

The older method of sand casting has very decided limitations especially when it comes to texture of the finished product. It was for this reason that advantages of the newer method were readily realized.

With the use of slides, Mr. Warren pointed out the significant components of a typical centrifugal casting machine. Essentially it consists of an electric furnace thermostatically controlled, in which the molten alloy is contained. A predetermined quantity of this alloy is measured by a balanced hopper. From the latter the hot metal is poured down a spigot which directs it to the internal periphery of a rotating water-cooled drum. As soon as the molten metal contacts this drum the latter moves longitudinally away. The result is a cylindrical shape of cast metal having an extremely homogeneous grain texture because of controlled chilling.

Numerous castings produced by the above process were on display and were inspected with interest by all present.

CALGARY

J. A. WEBB, M.E.I.C.,
Secretary-treasurer

R. G. PRICE, M.E.I.C.,
Branch News Editor

'Slide Rule Soirée'

The annual Calgary Branch ball, known as the Slide Rule Soiree was held on February 14, 1957, at the Palliser Hotel. A capacity crowd of more than three hundred were in attendance.

A floor show put on by engineers and their wives was enthusiastically received and was repeated for patients in Calgary's Colonel Belcher Hospital.

Introduction to P.D.

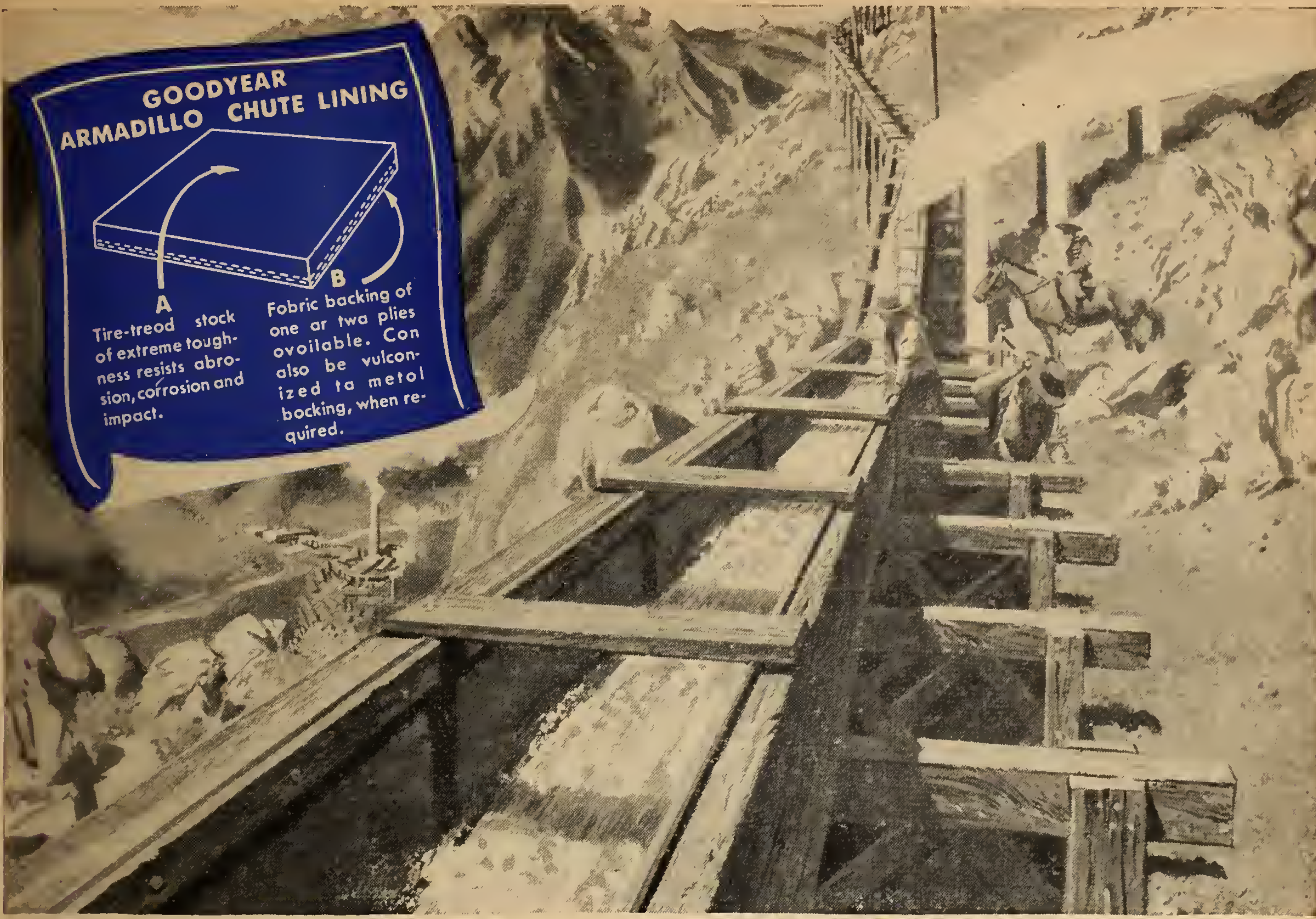
A capacity crowd also turned out for and enjoyed the first of two professional development meetings on March 5, at Penley's Academy. Addresses were presented by N. Emms Read of Calgary on "The Art of Public Speaking", and Dr. Dwight Palmer of Los Angeles, internationally prominent management consultant, whose subject was, "How to Motivate the Young Professional". The meetings were held in conjunction with the Alberta Society of Petroleum Geologists and the Canadian Institute of Mining and Metallurgy. Programs dealt with the subjects of Finance, Human Relationships, Management and Self-Expression.

Over the past six years great progress has been made by the E.I.C. in the field of professional developments across the country with as many as twenty-six branches actively engaged in these types of programs in a given season. After giving serious consideration to adding this type of personal development opportunity to their regular program of activities, program chairman F. L. Perry secured the services of four speakers, building a program broaching the field of professional developments and built around the speaker, rather than the subject.

N. Emms Read — N. Emms Read, manager of the International Correspondence Schools, at Calgary, is highly regarded in the field of public speaking and associated subjects. He has had twenty-five years' experience in training professional people in public speaking throughout Alberta. Mr. Read was one of the founders of the "Radio Round Table of the Air" and one of the best known speakers in Alberta. Many prominent Albertans owe their interest in "the Art of Public Speaking" to training received under the guidance of Mr. Read.

Dr. Dwight Palmer — Second speaker of the evening was Dr. Dwight Palmer of Los Angeles, manager and owner since 1945 of Dwight Palmer and Associates

Taken at the Slide Rule Soiree, annual ball of the Calgary Branch held in February, members and wives participating in the floor show are shown below. Fifty couples were unable to get seats for the popular event which drew a capacity crowd of more than 300.



Rubber armour can outlast steel 12 to 1

Goodyear Armadillo Chute Lining wins fight with 10,000,000 cubic feet of "Chuting Slurry"

As consulting engineer for a hard rock mining company, you're working on a new system for disposing of 10,000,000 cubic feet of concentrator tailings on a tough ten year project.

Conditions suggest gravity flow to stocking area in concrete conduit, metal pipe, or wooden or metal launders. You've ruled them out because none could withstand biting acids and abrasive slurry.

What kind of Armour could meet your long-term requirements? You recall a discussion you had with the Goodyear Representative who presented facts and figures to prove that Goodyear Armadillo Chute Lining has outlasted steel 12 to 1. You decide to give him a call. Soon, both of you are going over plans for a wooden chute that's protected by a hide of this tough, abrasion and corrosion resisant "rubber armour".

That was two years ago; since then your pet project has continued carrying an unending river of tailings from your back doorstep to the disposal area and it's still as good as new. Tire tread toughness of Armadillo Lining is so effective you're looking forward to trouble free operation for years to come.

Armadillo Chute Lining is your most effective deterent to abrasion wherever it occurs. The Goodyear Representative can recommend the Armadillo Lining best suited to reduce replacement costs. Call your nearest Goodyear Office . . . at Moncton, Saint John, Quebec City, Montreal, Toronto, London, Windsor, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver or Head Office, New Toronto.

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GOODYEAR

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consultants in management, industrial relations and organization. Dr. Palmer studied at Pomona College, where he majored in economics; at the University of Chicago graduate school of business, specializing in industrial management, labor law and labor economics; and in 1935 was awarded a Ph.D. degree in economics at Stanford University. During the next three years he also attended the London School of Economics and was engaged in post-doctorate research training at Geneva with the Inter Labour Office and League.

Professor E. D. MacPhee — On March 14, Prof. E. D. MacPhee, dean of the faculty of commerce, University of British Columbia addressed the group on "Professional Management". No greater authority on this subject existing in this continent, he is the ex-chairman, president or managing director of operating companies in textiles, leather goods, aircraft and chemicals and speaks on the subject as a highly successful business man, rather than as a university professor.

T. W. Meredith — Second speaker on this bill of fare was T. W. Meredith, manager of Osler, Hammond and Nanton who presented a talk entitled "The Investment Industry".

The Journal hopes to carry a full report of these meetings in an early issue.

CAPE BRETON

W. A. DODSON, M.E.I.C.,
Secretary

F.O. JOHN RICHARD, JR.E.I.C.,
Publicity Chairman

Tour R.C.A.F. Station

Through the kind invitation of the commanding officer, Squadron Leader L. J. Lomas, and the collaboration of the construction engineering officer, F.O. John Richard, the Cape Breton Branch had the pleasure of holding a well attended meeting at the Officers' Mess on March 14, 1957.

The group was welcomed by Squadron Leader C. A. Brunger, chief technical services officer, and guided through a limited tour of the station facilities. The trip wound up at the newly completed recreation hall and then adjourned to the Mess where an excellent buffet supper had been prepared for the "Gourmets".

W. A. McDonald, chairman of the Branch, expressed the thanks of the members for a most enjoyable and entertaining evening. He also congratulated the commanding officer and staff on the well organized reception and tour and the obviously efficient construction and operation of all facilities at the Station.

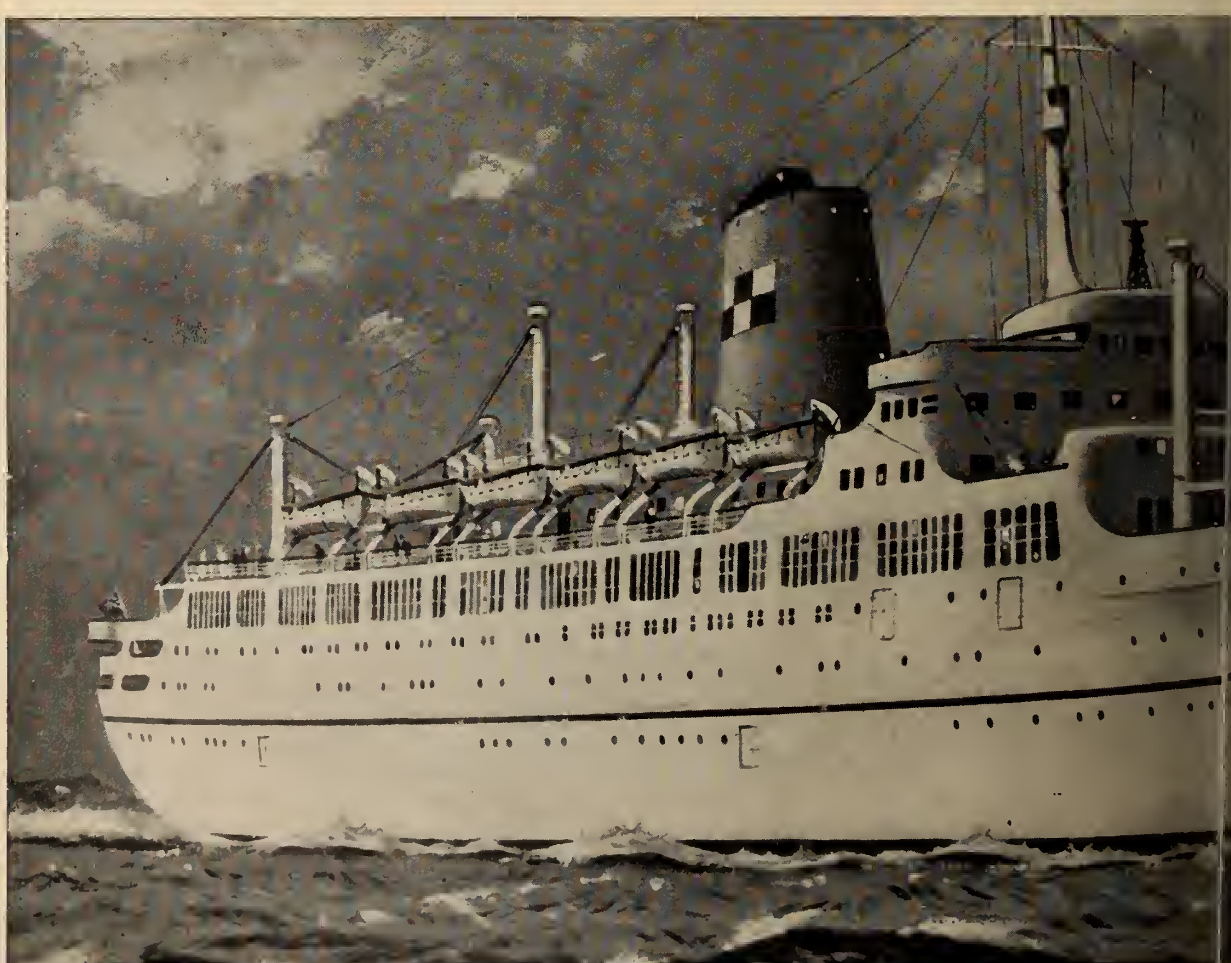
C. M. Anson Reports on UPADI

The monthly dinner-meeting of the Cape Breton Branch was held on February 20, 1957, under the chairmanship of Charles Campbell, treasurer.

For the occasion, C. M. Anson, vice-president and general manager of the Dominion Iron and Steel Company, Ltd., presented an informal report on the Pan-American Engineering Convention held in Mexico City. After refreshments and dinner, a deserving presentation to Mr. Anson was made by Mr. Laing, of Eastern Light and Power. Mr. Laing outlined the well-filled career of an engineer who can still find time and energy to identify himself with community life and spirit, even while carrying the burden of responsibilities and duties as the chief of steel operations at DOSCO.

Mr. Anson expressed his great pride in receiving the honour of the presidency of the Institute for 1957-58, from the finest group of authorities in the field, "his fellow engineers".

As representative of the E.I.C. at the UPADI convention, Mr. Anson was impressed by the feeling of co-operation and understanding, that prevailed throughout the meetings, where the chief



aim of everyone was, no doubt, the promotion of the engineering profession. In this respect, the Convention brought together engineers from all over the Americas, and through the dissemination of engineering information and understanding, endeavoured to advance the engineer's standing in the community and produce uniform engineering standards. After a look at the Congress, Mr. Anson led everyone around Mexico City and the magnificent countryside through the medium of fine color slides, all of which was to the credit of the man behind the lenses.

FREDERICTON

O. I. LOGUE, M.E.I.C.,
Secretary,

G. R. W. BLISS, JR.E.I.C.,
Chairman, Public Relations Committee

Association Council Guests

The March meeting of the Fredericton Branch was held on March 22 with chairman, Ira M. Beattie presiding. Special guests at the dinner were the council of the Association of Professional Engineers. This was the last general meeting of the branch before the annual meeting in April.

I. Beattie opened the meeting by welcoming the members and guests and introducing those at the head table. He then called on Prof. E. E. Wheatley, professor of mechanical engineering at the University of New Brunswick, to introduce the main speaker of the evening, R. D. Neill, mechanical design engineer, with the N. B. Electric Power Commission. Prof. Wheatley pointed out that Mr. Neill was a 1954 graduate from U.N.B., the second graduating class in mechanical engineering from that institution. Mr. Neill has been employed by the Commission since graduation.

Mr. Neill's paper was entitled "The Selection of the Most Economical Steam Conditions for Central Station Generating Units". He said that the statement has been made that the electric utility industry is one of the most cost conscious industries in America today. This attitude, he stated, has been fostered by the continual struggle to produce electrical energy at ever decreasing costs while the prices of all the factors which go into its production are continually going upward.

Mr. Neill said that although his paper dealt solely with thermal power plants, the methods of analysis outlined can be applied to any industry or situation where more than one system of obtaining a desired result is available.

The Chairman then called on J. L. Feeney, chief engineer of the Power Commission, who congratulated Mr. Neill on his presentation of the subject. He suggested that other speakers from the Branch ranks present papers at forthcoming sessions.

HAMILTON

W. A. H. FILER, JR.E.I.C.,
Secretary-Treasurer

J. R. CURRIE, M.E.I.C.,
Branch News Editor

President's Visit

This meeting, also considered as Ladies' Night, with the showing of the film "Leonardo da Vinci", held on February 21, 1957, marked the annual visit of the president and general-secretary to Hamilton. The Branch was most happy to welcome Mr. and Mrs. V. A. McKillop and Dr. Austin Wright. Over three hundred members and guests attended the affair.

Introduced by chairman D. B. Annan, Mr. McKillop spoke briefly concerning the responsibilities of engineers and the challenge presented the engineering profession in the future development of Canada as revealed by the Gordon Report. Mr. McKillop outlined the active interest taken by the Engineering Institute of Canada in the development and education of the young engineer.

The film was presented by Dr. Wright who gave a brief history of this outstanding work. The rights for showing the film in Canada have been obtained by the E.I.C., and many favourable comments have been accorded it by critics throughout the world.

Refreshments were served by members of the Ladies' Auxiliary.

Before the evening meeting, N. A. Eager held a cocktail party at which President McKillop met a number of the industrial leaders of the Hamilton area.

Papers Night

The annual students' and juniors' papers night was held on March 21, at McMaster University. Papers were presented for competition by G. R. Mason, V. O'Doherty, B. C. Compton, and J. C. Sinclair.

The winning paper was presented by J. C. Sinclair, for his work on the development of the transistorized remote broadcast amplifier. The newly developed broadcast amplifier was shown to the audience to illustrate the saving in space through the replacement of the older vacuum tubes with transistors. V. O'Doherty, who spoke on Low Voltage Switchgear Protection, and G. R. Mason, who presented the paper "Future Power in Canada", were also winners.

Judges were R. H. Stevenson, A. E. Archibald, and J. C. Buchanan. Prizes were presented by L. C. Sentance, past-president, and D. B. Annan, chairman.

LONDON

G. W. CHORLEY, M.E.I.C.,
Secretary-Treasurer

GEORGE HAYMAN, JR.E.I.C.,
Branch News Editor

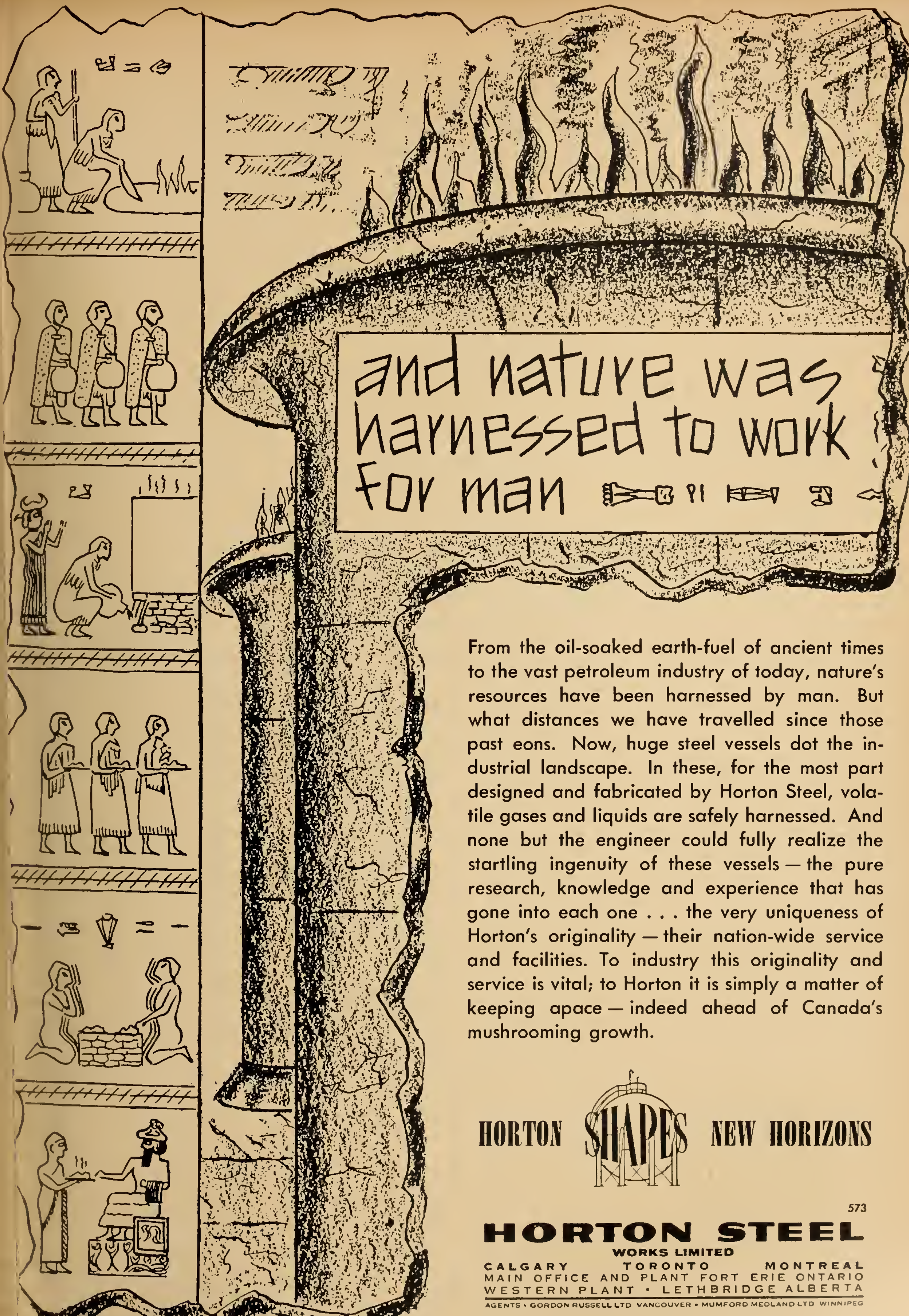
President's Visit

The February meeting of the London Branch took place in the form of the annual dance. This dance also marked the official visit of President V. A. McKillop to his own branch.

During the afternoon, prior to the dance, the local executive met with Mr. McKillop and Mr. Wright to discuss problems regarding the Institute locally and nationally.

About seventy members and their ladies attended the dance in the evening. It was generally regarded as one of the most successful ever held. A buffet supper was served at 10.30 p.m., followed by entertainment supplied by Dave Broadfoot, one of the stars of Toronto's Spring Thaw, which was playing in London at the time. Don Douns' orchester provided music for dancing.

Several local firms donated prizes which were awarded during the evening


and nature was harnessed to work for man

for special dances. Another highlight of the evening was provided by five of the local branch members who held a jam session with banjo, ukelele, piano, traps and gut bucket. This entertainment was presented at one o'clock and was warmly received. It is hoped that this may be repeated in years to come.

General Meeting

The March meeting of the London Branch was held on March 19 at Wolseley Barracks. Guest speakers were former city engineer Roy Garrett, alderman Terry Ferris, city engineer Eric Skelton and chief sewer engineer Frank Ball. These men took part in a panel discussion on the recent sewer survey in London.

Mr. Garrett outlined the past history of London and its sewer installations up to the present time. Mr. Ferris discussed the political problems leading up to city council hiring an outside consulting firm to survey London's sewer needs. Mr. Ball outlined the consulting firm's recommendations and Mr. Skelton described the action that has taken place and that which will follow, on these recommendations. Considerable expense is to be born by the London tax-payer as a result of these suggestions.

The branch members felt that this meeting helped clear minds of the confusion surrounding this issue. It has received a tremendous amount of publicity in the local press. This meeting served to consolidate the thinking on this subject as the newspaper had seemingly failed to do prior to the discussion.

MONTREAL

JEAN RIEL, S.E.I.C.,
Students' Representative

Students' Night

Le 11 février dernier avait lieu le "Students' Night" annuel, aux quartiers généraux de l'E.I.C. Ce "Students' Night" est un concours oratoire entre deux étudiants de l'Université McGill et deux étudiants de l'Ecole Polytechnique. Ces étudiants présentent des sujets techniques se rapportant au génie. Ils sont jugés d'après la valeur du sujet choisi et leur habileté à le présenter.

Cette année monsieur Jules O'Shea de l'Ecole Polytechnique remporta le premier prix en présentant son sujet: "A Grammatical Word Computer", c'est-à-dire une description d'un compteur électronique pour calculer le nombre de mots écrits sur un dactylographe. Il est intéressant de noter que monsieur O'Shea est l'inventeur de ce compteur électronique.

Monsieur Claude Villeneuve de McGill, qui fut choisi second, exposa la formation d'un "Retaining Wall" employé sur un champ de construction en vue de l'agrandissement d'une usine.

Le troisième prix fut décerné à monsieur Georges Starke de l'Ecole Polytechnique. Son sujet s'intitulait: "A Thermal Model of Heated Flat Slabs used as Floors in Basementless Houses". C'est un travail qui a été élaboré au Conseil National des Recherches à Ottawa, durant l'été dernier.

Enfin moniseur John Gillman de McGill présenta "An Electrical Estimating". Ceci était un exposé concernant l'évaluation d'un projet en électricité.

L'invité d'honneur était monsieur Léo Roy, président de la Corporation des Ingénieurs de la Province de Québec et président du comité exécutif de l'E.I.C. (division de Montréal.) Il présenta les prix et les certificats de l'E.I.C. au gagnant et aux trois autres étudiants.

Les trois juges étaient monsieur G. L. MacLean, président sortant de charge de la section junior de l'E.I.C., monsieur H. S. Racey de Racey, MacCallum and Associated Limited, et monsieur R. Langlois, professeur de l'Ecole Polytechnique.

Deux courts métrages furent présentés pendant que les juges délibéraient.

La soirée fut très intéressante et un nombre imposant de membres furent présents.

Students' Night

The annual "Students' Night" was held last February 11, 1957, at E.I.C. headquarters. This so called "Students' Night" is an evening during which two students from McGill University and two students from l'Ecole Polytechnique present technical subjects concerning engineering. They are judged according to the value of their chosen subject and their ability to present it.

This year, Jules O'Shea from l'Ecole Polytechnique won the first prize in presenting the paper, "A Grammatical Word Computer". This was a description of an electronic computer used to add the number of words written on a typewriter. It is interesting to note that Mr. O'Shea invented this electronic computer.

Claude Villeneuve from McGill, who took second place, explained the formation of a "retaining wall" which was used during construction of a building.

Third prize went to Georges Starke of L'Ecole Polytechnique. His subject was: "A Thermal Model of Heated Flat Slabs used as Floors in Basementless Houses". This was work done at the National Research Council in Ottawa last summer.

John Gillman from McGill presented "An Electrical Estimating". This concerned the evaluation of an electrical project.

L. Roy, president of the Corporation of Engineers of Quebec and chairman of the executive committee of the Montreal Branch, was guest of honour. He presented the prizes and the certificates to the winner and the other students.

The three judges were G. L. MacLean, ex-chairman of the Junior Section of the E.I.C.; H. S. Racey, of Racy MacCallum

and Associates Ltd.; and R. Langlois, Professor, from l'Ecole Polytechnique.

While judging was in progress, two short films were shown. The evening was most enjoyable and was attended by many members.

NIPISSING AND UPPER OTTAWA

G. R. KARTZMARK, JR.E.I.C.,
Secretary-treasurer

J. W. MILLAR, E.I.C.,
Branch News Editor

President's Visit

On March 8, 1957, the Nipissing and Upper Ottawa Branch was honoured by a visit from the president of the national organization, V. A. McKillop and Mrs. McKillop. During the afternoon the executive committee met with Mr. McKillop and discussed Institute affairs. Later a tour by H. R. D. Graham, regional manager, was made of the Ontario Hydro's new regional offices in North Bay.

While Branch members were occupied with the foregoing activities, wives entertained Mrs. McKillop at tea at the home of Mrs. Macnabb, wife of Branch chairman, T. C. Macnabb.

In the evening an informal dinner and dance was held. Mr. T. C. Macnabb, chairman, presided and President McKillop was introduced by J. S. Cooper, branch councillor. Mr. McKillop is general manager of the Public Utilities Commission of London, Ont. and president of the Canadian section of the American Waterworks Association, as wel as president of the E.I.C.

In addressing the gathering, the president pointed out the important role that the engineers had played in the development of Canada. He said Canada was a nation of only 16,000,000 people and yet held fourth place in world trade. Part of this happy state was due to abundance of power. He called for engineers to become united to gain better recognition and mentioned that the membership in the Institute had doubled since the war and there were now 47 branches across Canada. He strongly supported confederation of organizations of engineers and expressed the belief that in the end the effort would be well worth while. Mr. McKillop said he was much interested in engineering education. Canada has been suffering from a shortage of engineers and scientists for many years and this problem was studied at an engineering education conference in May, 1956. Mr. McKillop urged that branches make their programs attractive in order to bring people together. This problem had been greatly increased as over one million Canadians had moved into suburban areas since the war.

PETERBOROUGH

D. B. CHASE, JR.E.I.C.,
Secreary-treasurer

V. AARE, M.E.I.C.,
Chairman, Publicity

Visit to Quaker Oats Plant

Great interest in the local industry and E.I.C. activities was reflected in the splendid turnout of members and guests for the visit to the Quaker Oats Company of Canada Limited plant in Peterborough on February 27, 1957.

About 80 persons enjoyed the tour under the guidance of Albert J. Bonney, M.E.I.C., plant engineer, and other members of the company's staff.

Visitors saw the operations of flour and feed mills, manufacturing processes

for shredded wheat, muffets and other cereals of the well-known Quaker brand. The tour gave a good picture how the modern flour mill meets market's demands of special cereals, flour mixes and special feeds. Some of them have over ten ingredients and the machinery is capable of mixing as low as a few pounds of a certain ingredient per ton of total mixture in a continuous process with great accuracy.

It is also interesting to note that the Quaker plant in Peterborough was founded in the beginning of the century to supply the British market with rolled oats and flour. Today, the biggest products in dollars are ready-to-eat cereals for the Canadian market.

As the majority of visitors are in their daily work engaged with the electrical industry, the company's hydro-electric plant and substation were also inspected. The power plant lies on nearby Otonabee river and has three 1800 KVA generators.

After the tour, a light lunch was served in the company's cafeteria where M. E. Clarke, plant superintendent, welcomed the engineers and their guests. Mr. Clarke gave a brief summary of the company's operations and answered questions.

A brief business meeting was conducted by W. H. Ackhurst, Branch chairman. R. A. Blount thanked the company officials for the interesting tour.

In the first half of 1957 the Peterborough Branch will have several more field trips. An inspection tour of Peterborough's new million dollar Memorial Community Centre will be made and some of the latest hydro-electric power developments in Ontario will be visited.

SAULT STE. MARIE

L. F. MASON-TULBY, M.E.I.C.,
Secretary-treasurer

President's Visit

The Sault Ste. Marie Branch of the Institute was honoured with the visit of President V. A. McKillop at its annual meeting, held March 5, 1957.

Arriving in the early part of the day he attended a luncheon meeting of the Branch executive in which confederation was the main issue of discussion. During this time, Branch members' wives, Mrs. K. H. Snell, Mrs. Mason-Tulby and Mrs. K. Kansikas entertained Mrs. McKillop at lunch.

After an early evening appearance on T.V. President McKillop joined Branch members for refreshments and dinner at the Country Club. Guests at the affair included Professor R. C. Brown of the Michigan Institute of Mining and Technology and Mrs. Brown and Ralph Tinkney, of the Toronto Branch of the E.I.C. Mr. Tinkney was in the city on an engineering inspection assignment.

Addresses Branch — Addressing the Branch at dinner, Mr. McKillop stressed the fact that confederation of the two major professional engineers' groups in Canada is an aim of the membership of the Institute. He also emphasized that the time had come to eliminate personalities and protect the futures of the Institute and the Association of Professional Engineers. Mr. McKillop said that the opportunity now exists to think of unity as a means to minimize our differences and look for accomplishment of aims towards building a better, and stronger association and furthering engineering education.

He also commented on the shortage of engineers in relation to the construction and expansion of industry.

Uneasy Balance — Insofar as education was concerned Mr. McKillop felt that there had never been a time when so many people were concerned about education. With three jobs available for every newly graduated engineer, this is an uneasy balance. Although it was encouraging to know that the number of freshmen in universities has increased by

18 per cent he pointed out that this does not mean that there are eighteen per cent more graduates. With industrial requirements for engineering graduates increasing by 11 per cent annually, this is not enough. It was, he felt, just an example of the responsibility which exists for the future in the expansion of technological improvements and multiplying the ability to produce. He pointed to power developments in the St. Lawrence Seaway and in British Columbia as signs of the Canadian national production growth and said that the Institute anticipates the continuance of this growth.

International Standing High — Mr. McKillop rates the international relationships of the Institute highly and pointed out that Canada and its engineering advances enjoy the same reputation in the estimation of international and commonwealth groups.

President McKillop was thanked for his talk by Frank MacKay, chief engineer of the Great Lakes Power Company. The dinner was followed by dancing.

Before leaving the following morning, March 6, President McKillop was taken on a tour of parts of the Algoma Steel Corporation plant at Sault Ste. Marie under the direction of K. H. Snell and K. Kansikas.

Head table guests attending a dinner in honour of President V. A. McKillop during his visit to the Sault Ste. Marie Branch are shown below. Left to right are Miss E. Cassell, L. F. Mason-Tulby, Mrs. McKillop, K. H. Snell, Alderman Frank Ianni and Mrs. L. F. Mason-Tulby.

SASKATCHEWAN

R. BING-WO, M.E.I.C.,
Secretary-Treasurer

Annual Meeting

The thirty-ninth annual meeting was held at the Hotel Saskatchewan, Regina, on Friday, February 15, 1957 with E. J. Durnin, Branch chairman presiding. Approximately 125 members were in attendance.

Before commencing the formal business of the meeting, the chairman introduced guests representing the Western professional engineering associations. They were W. A. Merchant, registrar of the B.C. association, A. E. McDonald, executive-secretary, Alberta, and J. Hoogstraten and L. Bateman, of Manitoba.

The report of the Committee on Professional Development was presented by Dr. J. D. Mollard, chairman. E. F. Dur-

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Driftite	Geogel	Nitropel	Vibrex

rant had acted as co-chairman. Dr. Mollard reported that 48 persons registered for the course, with an average attendance of 32. Nine lectures were held between September and December. The subjects covered a wide range of subjects, including finance, advertising, industrial relations, the arts, international affairs. The course was concluded by a banquet and dance at which more than 170 were present. The committee recommended that a sub-committee on Professional Development be set up to operate under the general direction of the Papers and Meetings Committee and that the Professional Development Committee ascertain the wishes of the membership by distributing a questionnaire. A suggested questionnaire was filed with the report.

Reports were received from Saskatoon, Prince Albert and Moose Jaw sections of the Branch. Lee G. Morrison, president of the Engineering Society at the University of Saskatchewan reported on activities of the engineering students.

Prof. J. B. Mantle presented the report of the Student Guidance Committee and said that thirteen high school principals had been informed of engineers in their area who would be suitable to give guidance advice to students on engineering as a career.

TORONTO

D. S. MOYER, JR.E.I.C.,
Secretary-treasurer

A. C. DAVIDSON, M.E.I.C.,
Branch News Editor

Atomic Power Talk

Ian N. MacKay addressed the Toronto Branch on "Progress in Atomic Power", on February 28 at the University of Toronto in an informative talk on the various aspects of power generation, using reactor type boilers in Canada, the United States and in Great Britain.

Presently associated with the Civilian Atomic Power Department of the Canadian General Electric Co. Ltd., as manager of engineering, Mr. MacKay was with the Atomic Energy Commission at Chalk River from its early stages, leaving to join C.G.E. in Peterborough in 1955.

Any nuclear reactor for steam generation is essentially a container holding a number of uranium rods, or some form of uranium rods, surrounded by a moderator. The rods are allowed to get hot, and the heat is removed by some transfer medium which in turn yields up its heat to a more conventional medium such as water. The whole assembly must be kept from corroding, both in the usual ways employed in any boiler installation, and by fission products.

Canadian Installation — The Canadian installation consists of a steel tank made up of plates 5 inches thick. The container is 11½ feet in diameter, and 37 feet high, weighing 150-160 tons. The head alone weighs some 60-70 tons. It contains 109 tubes of a zirconium alloy which in turn hold the fuel rods of sintered uranium dioxide. The fuel is actually in the form of pellets about ½ inch in diameter and ¾ inch high stacked in the tubes. There are two cylindrical shields which protect the reactor vessel from the gamma radiation of the core. The moderator is heavy water, presently obtained from the United States.

The Canadian reactor is the most compact of all those presently built or building, and shows great promise of producing nuclear power more economically than is being done just now. The reactor is called N.P.D. or Nuclear Power Demonstrator, and is intended for demonstrating only, rather than for

This blast furnace bustle pipe is one of a number of components built by MLW for the Dominion Foundries and Steel Company's recently completed No. 2 blast furnace at Hamilton, Ontario.

Dofasco's No. 2 blast furnace during construction.

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power generation on a continuous basis, although it can develop 20,000 kw. It is hoped that the construction of the plant will demonstrate the practicability of nuclear power generation to the public, as well as to various groups interested in power generation, and of course supply cost data.

American Reactor — The American reactor, (PWR) being built presently for the Duquesne Power Corp. is slightly smaller than the Canadian reactor. It uses enriched uranium and light water. The control is different to the Canadian method, and is done by lowering moderator rods into the reactor. Although apparently simple in operation, the rods sometimes stick which is obviously dangerous. Sticking rods did in fact contribute to the accident in the Chalk River reactor, so that the NPD reactor is arranged on an "inherent" shut down basis, involving the movement of heavy water, a fluid, through large orifices, rather than a solid rod into a tube.

Calder Hill Station — The British nuclear power station at Calder Hill is notable for its great size. The reactor itself is some 37 feet in diameter and 70 feet high, using a graphite moderator, the whole weighing some 1700 tons. Heat transfer is affected by using carbon dioxide gas. There are four heat exchangers with some eight acres of transfer surface. The great size of the Calder Hill equipment is not from choice, but from economic necessity. There is not the power available in Britain to manufacture heavy water. Faced with a dwindling coal supply, and increasing power requirements, the British had to get power from nuclear fission, and get it quickly. Right now the British have something to show customers on the continent of Europe, who may wish to purchase equipment.

Customers in South America are not too anxious to buy reactors using enriched uranium, they are interested in equipment which can operate on materials available at home should a world crisis develop, cutting them off from the United States.

In the ensuing discussion, Mr. MacKay brought out the fact that the cost of power from nuclear fission is about 50 mils per kwh in the U.S., 10-15 mils in Britain, and about 20 mils in Canada. The figure for Britain should be used with caution, as the method of write-off for plant is entirely different to that in Canada and the U.S. The NPD will use about 21 tons of fuel per year, which can be supplied very easily by Canadian mines. Cataclysmic failures of the plant are not expected.

Altogether, the generation of power using a nuclear reactor as a steam generator is not only feasible, but practical and cheap. These established facts are in contrast to an excerpt from the Journal of Applied Physics, vol. 10, Sept. 1939, shown by Mr. MacKay. The writer of the article could not envisage practical applications for fission for a very long time to come.

VANCOUVER

A. D. CRONK, JR.E.I.C.,
Secretary

T. F. HADWIN, M.E.I.C.
Branch News Editor

Inspection Trip

The new Vancouver Post office will have many devices for efficient operation that are classed as the "first in the world". Some of these were described to members of the Vancouver branch of the Institute on February 16 when they were conducted through the building by representatives of the engineers and architects; McCarter, Nairn and Partners,

and of the contractors, Smith Bros. and Wilson Ltd.

J. H. Swerdfeger, M.E.I.C., gave a brief talk on the $13,000,000 building and then assigned the visitors to guides who first took their parties to the top floor and penthouse structure. This section houses the offices and is designed for seven additional floors when required. Dropping floor to floor the elaborate conveyer systems were described. For the Vancouver area alone mail is first split into about 30 zones.

Construction is just starting on the conveyer tunnel from the post office basement to the C.P.R. station. Trucks will handle mail to and from other transportation terminals.

When completed in October, 1957 Vancouver will have the most modern mail sorting system that is economical to design and have built at this time.

Shown standing in this wood stave pipe are some of the members of the Vancouver Branch during a field trip to the Pacific Coast Pipe Company, Limited, which was reported in the April issue of the *Journal*.

Architects' conception of completed plant

TO keep ahead of the rapid load growth, occasioned by rural electrification and industrial expansion, the Saskatchewan Power Corporation has constantly anticipated the needs of its customers.

Latest step in a long-range expansion program is the new South Saskatchewan River Generating Station. The completed plant will consist of four 66,000 KW generators. The initial two units will each be served by a 600,000 lbs. per hour Foster Wheeler steam generator, operating at 870 psig at 910°F and arranged for pulverized coal, oil, and gas firing.

The use of combination radiant and convection surfaces, in conjunction with FW condenser type control for superheating, permits constant final steam temperatures over a wide operating range, stabilizing steam conditions for maximum turbine efficiency.

The units are conservatively rated, with low heat absorption rates per unit area and low furnace exit gas temperatures. Each steam generator is equipped with two ball mill pulverizers and eight burners to further contribute to high fuel economy per pound of steam.

The proved dependability and long-range economy of Foster Wheeler steam generators are backed by more than 50 years of experience in pioneering power plant equipment. For further information consult Foster Wheeler Limited, St. Catharines, Ontario.

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News of Other Societies

ASCE Spring Convention, Buffalo

Civil engineers from the United States and Canada, and other parts of the world will meet in Buffalo, N.Y., in large numbers for the Spring Convention of the American Society of Civil Engineers, June 3 - 7, 1957.

Focal point of the convention will be the St. Lawrence seaway and power projects. The program features many papers and discussions concerning the design, construction and administration of the seaway. Supplementing this information there will be an extensive one-day tour of the St. Lawrence sites.

ASCE Divisions will sponsor tours and inspection trips in the Buffalo area: the New York State Thruway (the highway division); Bethlehem Steel's Lackawanna plant (structural division); the Canadian Sir Adam Beck hydroelectric station, the Huntley steam electric generating station, the remedial work at Niagara (the power division).

These three divisions, as well as the other ASCE divisions (construction, hydraulics, waterways and harbors, sanitary, soils mechanics and foundations, and the committee on conditions of practice) have also provided technical papers.

Some of the St. Lawrence seaway and power project phases to be dealt with in papers will be: hydraulic model research; design features associated with regulation of water in the project area; water intake design; earthwork features in the International Rapids Section; the canals and channels and locks; special highway problems; electrical engineering features.

An afternoon session for Wednesday, June 5 will be conducted by the Engineering Institute of Canada, and features papers by D. A. Chamberlain, Jr., by T. Broendum-Neilson and Per Hall, and by E. John Racey. Canadian personalities will participate in other phases of the program also as speakers or chairmen. They are: M. V. Jones, Metropolitan Planning Board, Toronto; J. M. Muir, Dominion Council of Professional Engineers; Otto Holden and J. B. Bryce, of H.E.P.C. of Ontario; W. D. Baines, National Research Council; R. H. Clark, Department of Northern Affairs and National Resources, and others.

Headquarters of the Convention will be the Hotel Statler in Buffalo.

C.I.M. Convention

The Canadian Institute of Mining and Metallurgy met for its fifty-ninth annual general meeting at the Chateau Laurier, Ottawa, on April 22, 23 and 24, 1957.

The program commenced with a business meeting of the Geological Association of Canada, chaired by H. C. Gunning; followed by meetings of the John T. Ryan Trophies Committee, the Sixth Commonwealth Mining and Metallurgical Congress committee, and annual business conferences of the coal, geology, industrial minerals, metallurgy and metal mining divisions.

Greetings were extended by His Worship the Mayor of Ottawa, during the luncheon, April 22. The guest speaker, the Honourable George Prudham, minister of Mines and Technical Surveys of Canada, in his address on "Government in Industry in a Free Economy", said that with particular reference to the mineral industry the relationship between private enterprise and government in a free economy should be that of a practical partnership with the common aim of producing the greatest possible economic benefits for the greatest possible number of people. The state must supply some of the conditions, both practical and intangible, indispensable to industrial advance. The state can be valuable in fostering and providing that ingredient known as confidence; however it is the personal drive, initiative, and enterprise of individuals which forms the dynamic progress in a free economy.

Keeping pace with today's rapid development, the Department had realized the need for radically new departures in order to speed up geological survey work.

This had been accomplished. A very extensive program is also under way in 1957, with the main object of evaluating the mineral possibilities of the Canadian north.

Mr. Prudham urged Canadians to foster and maintain the individual enthusiasm of adventure and enterprise in order to rise to the challenge of this country and its resources. He added that it is to be hoped that social measures and social security, prominent in the public eye today, will never become an end in themselves.

The inaugural general session and a symposium on the St. Lawrence seaway and power projects comprised the afternoon's program.

Further technical sessions were held the following day, April 23. Presentation of the Institute honours and awards was made following the annual dinner. President-elect, Dr. Horace J. Fraser, president of Falconbridge Nickel Mines, Limited, of Falconbridge, Ont., was introduced. Guest speaker for the event was Dr. W. A. Mackintosh, C.M.G., vice-chancellor and principal of Queen's University, Kingston, who spoke on "Challenges of Growth." Dr. Mackintosh warned that Canada, difficult to develop, over the past three hundred and fifty years, will for obvious reasons continue to present problems. Greater than the need for industrial resources or capital, he said, was the need for educated persons of integrity; and in all fields of endeavor. No luxury, this is an essential of national life.

On the pressing subject of university expansion in Canada, Dr. Mackintosh stated that the question is not whether or not universities expand and multiply, but whether they do so in a way which will produce first class results? Variety in outlook, reasonable autonomy and specialization among them, will be necessary, as well as a greater number of technical institutes; an enlarged and improved corps of teachers, scholars, and scientists, and, of course, added facilities, and a selection of students, due to growing numbers. The range and stature of a select group of the graduates must be increased, as well as the number of classes graduating.

Turning to the international scene, Dr. Mackintosh felt that Canada has now shown readiness to exercise her own judgment in matters previously conceded to other nations. Regarding the investment of foreign capital in this country, it should be remembered that without external investment, the whole rate of progress and development would be sharply reduced.

The induction of the incoming president, Dr. Horace, J. Fraser, the reading of the presidential address and that of Charles Gavsie, guest speaker and vice-president of the St. Lawrence Seaway Authority, highlighted the last day's activities.

The president's reception and the annual dance rounded out the three-day affair.

Library Notes

Additions to the Institute Library
Reviews, Book Notes
Standards

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

AIR CONDITIONING REFRIGERATING DATA BOOK; APPLICATIONS VOLUME. 6th ED.

This useful handbook has had a number of revisions, in various chapters, notably those pertaining to food refrigeration. Specific problems and data are given, as usual, in this applications edition. Sections are: frozen foods; refrigeration in food industries; refrigerated warehouse practice, refrigerated food distribution; low temperature applications, industrial applications of refrigeration; comfort air conditioning; and industrial air conditioning. American Society of Refrigerating Engineers, New York, The Society, 1956. Irreg. pging, $10.50.

AMERICAN HIGHWAYS TODAY

This collection of twenty-eight articles and speeches on the history, problems and future of American highways is a valuable addition to the literature on current road administration and construction. Pro and con arguments regarding compulsory auto insurance, tax and toll schemes to finance highways, the trucking industry and road upkeep, and American legislation on traffic are presented. The final section explains the U.S. 1956 Federal-Aid Highway and Highway Revenue Acts. This is the first number of volume 29 of the Wilson Company Reference Shelf series, and a full bibliography is included. P. Tyler, ed. New York, Wilson, 1957. 204p., $2.00 (U.S.).

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS
Monday to Friday
9 a.m. — 5 p.m.
Saturday 9 am. - 12 noon.

ANALYSIS FOR PRODUCTION MANAGEMENT

Growing out of a course given at M.I.T. by the authors, this book tends to concentrate on the economic problems of production management, presenting the methods developed for their analysis.

The book is divided into four sections, the first of which provides an historical introducton and general background material. The second covers programming, including linear programming, whilst the remaining two deal with statistical and economic analysis. Throughout the book, the theory and generalizations are illustrated by concrete examples, and problems are presented at the end of each chapter. Ten cases are presented at the end of the book, giving as accurate a picture of the production operation as possible, and leaving the reader, or student and instructor to decide how the problem would best be solved by the use of the formal methods of analysis expounded in the text.

This should prove a very useful text. E. H. Bowan and R. B. Fetter. Homewood, Ill., Irwin, 1957 503p., $6.50 (U.S.).

BOILER HOUSE PRACTICE, 2nd ED. REV.

This basic text, newly revised, gives information on the most recent developments in boiler house practice. The entire range of subjects covered by the syllabuses of the Boiler House Practice courses of the City and Guilds of London Institute is treated in the book under the following headings: theory and practice of combustion; heat transmission; boilers and boiler operation, control and feeding; coal and coke; oil fired boilers; refractory, insulating materials and lagging; cleaning and maintenance; measurements and tests.

This present book supersedes the author's *Steam Generation* which was published in 1946, and was recommended as a text by the City and Guilds. J. N. Williams. London, Allen and Unwin, 1956. 624p. 60/–.

*BUILDING COST MANUAL

This manual provides tabulated data contributed by more than 150 architects, engineers, builders, and manufacturers all over the U.S. Parts 1 and 11 give brief introductory information on cost data and their use, regional variations and cubing instructions. In Part III 150 classified building types are illustrated photographically, each accompanied by a tabulation of structural elements and materials, mechanical equipment and base costs. Photographic depictions of many older types are included with code numbers showing the nearest modern equivalent in each case for determining present replacement costs. American Institute of Architects, Chicago Chapter and Chicago Real Estate Board. New York, Wiley, 1957. 367p. $15.00.

COMPANY INVESTIGATIONS OF AUTOMATI[C] DATA PROCESSING

The increasing number of firms investigating the possibilities of using automatic equipment for data processing wi[ll] find this report both interesting and use[ful].

The author discusses the approache[s] of different companies in investigatin[g] their data-processing needs to determin[e] what equipment, if any, should be pu[r]chased. The report falls into three se[c]tions, the first of which describes brie[f]ly the various types of automatic equi[p]ment available and its uses.

The second part is devoted to actu[al] case histories, including a detailed repo[rt] of the experiences of one company fro[m] the time when it was first decided to i[n]vestigate the possibilities of the actu[al] installation of a computer.

The final section discusses various a[s]pects of the problem including organizi[ng] for the project, selecting an applic[a]tion for the computer, cost and savin[g] estimates, selecting equipment, and rel[a]tive merits of punched-card and aut[o]

matic installations. P. B. Laubach. Boston, Harvard School of Business Administration, 1957. 259p., $3.00. (U.S.).

DETERMINATION OF MOISTURE IN SOLIDS

A survey of the known methods of determining the moisture content of solids, this book includes brief descriptions of the forty techniques surveyed, together with references to further material on each. Apparatus commercially available in England for use with each method is also listed. There are indexes to the authors of the references listed, and to the manufacturers of apparatus. P. J. Geary. Chislehurst, Kent, British Scientific Instrument Research Assoc., 1956. 51p., 9/6.

DIGITAL CALCULATING MACHINES

Written primarily for engineers and scientists, this book discusses the various types of digital calculating machines available, and their use in solving problems.

The machines are divided into four groups. The first has a limited storage capacity, and includes all the usual desk-type calculators. The second, represented by punch-card systems, has a large storage capacity for numbers but not for instructions. Group three has a limited storage capacity for numbers, but the machines will perform a variety of operations. The machines in this group are usually special-purpose machines. The last group of machines has an extended storage capacity for both numbers and instructions, and includes the large general-purpose computing machines or "electronic brains."

Examples of problem-solving with calculating machines are given throughout the book, and a final chapter deals with programming for large computers. References for further reading are included. G. A. Montgomerie. Glasgow, Blackie, 1956. 262p., 30/-.

*ELEMENTS OF GASDYNAMICS

Stressing fundamental theory, this book deals with waves in supersonic flow; flow in ducts and wind tunnels; small-perturbation theory; transonic flow; and other topics of interest to engineers who work on problems involving the aerodynamics of compressible fluids. The book has been written as a text for senior and graduate courses and as an introduction to the more specialized studies for practicing engineers. H. W. Liepmann and A. Roshko. New York, Wiley, 1957. 439p. $11.00.

*ENGINEERING STRUCTURAL FAILURES

The author has surveyed the causes and results of failure for over a century of engineering in various types of structures including earthworks, dams, sea walls, wharves, buildings, bridges, and tunnels. Vibration problems in foundations, earthquake effects, and cracking in welded steel structures are also considered. The last chapter deals with the lessons of failure and various modern methods of testing materials, such as the strain gage, scale models, the de Havilland moving-coil vibrator, and X-rays. Among the famous cases of failure discussed are the Knickerbocker Theatre in Washington, the Quebec and Tacoma Narrows bridges, and the Sydney water-pressure tunnel. Rolt Hammond. New York, Philosophical Library, 1956. 224p., $12.00 (U.S.).

THE FINAL FORMING AND SHAPING OF WROUGHT NON-FERROUS METALS

Included in this volume are the eight papers presented at a Symposium held in April 1956, together with the discussion on them.

As indicated by the title, the papers are all concerned with the final forming and shaping of non-ferrous metals and include machining properties, deep drawing and spinning, cold roll-forming stretch-forming, bending, the hot forming of magnesium alloys, and rubber pressing.

The paper on machining properties is by Dr. D. F. Galloway, who, members will recall, gave a special address at the 1956 annual meeting of the Engineering Institute of Canada. This volume is the twentieth in the series of Monographs and Reports issued by the Institute of Metals. London, Institute if Metals, 1956. 128p., 21/-.

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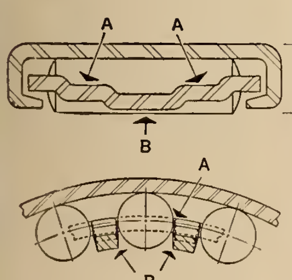

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*A HISTORY OF TECHNOLOGY, VOLUME 2. THE MEDITERRANEAN CIVILIZATIONS AND THE MIDDLE AGES

This is the second volume of a series of five which will cover the development of technology from the Old Stone Age to the later 19th century. The first volume, already published, was from early times to the fall of ancient empires c.500 B.C. The present one covers the Mediterranean civilizations and the Middle Ages. Only the technology of Europe is dealt with, and the concern is mainly with the development of processes, techniques and devices rather than with social and economic implications. The range of subjects includes all those activities which provide for material needs: mining, quarrying, metallurgy, agriculture, leather, textiles, ceramics, glass, building construction, transportation, metal work, machinery, power, hydraulic engineering and sanitation. Six hundred ninety-five illustrations including maps and diagrams and an additional 44 plates are provided. Literature sources are found at the end of each chapter, and personal and place name indexes are appended. Charles Singer and others, eds. Torinto, Oxford, 1956. 802p., $25.50.

HOW TO INSTALL AND SERVICE INTERCOMMUNICATION SYSTEMS

Enough information is given in this book to enable the qualified reader to install and maintain an electronic intercommunication system.

The book is based on the author's experience, and covers basic amplifiers, a-c and a-c/d-c systems, wireless systems, paging systems, one and two way systems, and requirement for particular applications. An appendix lists American manufacturers of intercommunication systems. Jack Darr. New York, Rider, 1957. 151p., $3.00 (U.S.)

*INTERNATIONAL ASSOCIATION FOR BRIDGE AND STRUCTURAL ENGINEERING. PUBLICATIONS, VOLUME 16

Twenty-eight papers, 16 in English, 6 in French, and 6 in German, with titles and summaries given in three languages. Some examples of the topics covered in the papers are: analysis of thin-walled continuous shells; scale model investigation of shell roofs; a method for calculating circular cylindrical shells; the plastic design of aluminum structures; vibrations in steel and reinforced concrete bridges; impact accompanied by fatigue; and assembly of prefabricated reinforced concrete components for hangers. Zurich, Verlag Leemann, 1956. 550p., price not given.

AN INTRODUCTION TO JUNCTION TRANSISTOR THEORY

This study is intended to bridge the gap between solid state physics and the circuit properties of a junction transistor for the electronic engineer. It develops the basic theory of transistor action from the discussion of crystalline structure and electron movement in crystals to the setting up of a representative small-signal equivalent circuit. This circuit is suitable for use in the design of small-signal amplifiers covering the entire useful range of the transistor. For the circuit designer, formulas are given for its transformation to a form usable in a practical transistor. R. D. Middlebrook. New York, Wiley, 1957. 296p., $8.50.

*INTRODUCTION TO OPERATIONS RESEARCH

A general survey of this rapidly growing field is presented with particular reference to industry covering such subjects as inventory, waiting time, allocation, and replacement models. The setup of scientifically valid conditions for model testing, including the defining of properties and conditions of observation, and the checking of test results, is the subject of a later chapter. The concluding parts deal with the control and carrying out of the solution in actual practice, and with administration problems. Case histories illustrate each method and models and chapter bibliographies provide for further reading. C. W. Churchman and others. New York, Wiley, 1957. 645p., $12.00.

L-C OSCILLATORS

General information on L-C oscillators in this publication includes oscillator elements, energy conversion, frequency range, stability, power considerations, oscillator efficiency, harmonic generation, series and parallel resonance, and critical damping. The section entitled circuit analysis treats the factors affecting the feedback loop and the circuit requirements for an amplifier to reach a condition of oscillation. Following sections cover low, medium and high frequency oscillators. This is volume 13 of Rider's Electric Technology Series. A. Schure, ed. New York, Rider, 1957. 66p., $1.25 (U.S.).

LOW POWER TELECASTING

Because of recent interest in local community telecasting this book has been written to give basic information on such

matters as: lower power antennas; signal propagation and prediction of coverage; low power transmitters; the Vidicon pickup tube and camera lens; Vidicon camera chain for live pickup and film; and station installations. Actual economy stations, planning procedures, space, conduit, and power requirements are described. H. E. Ennes. Indianopolis, Sams, 1957. 106p., $2.95. (U.S.).

MANUAL ON INDUSTRIAL WATER. 1956 ED.

This standard manual is intended as a general reference book for those concerned with the many uses of water in industry. It is intended as a guide for all types of personnel, although the water specialist will find only general information in this publication. Subjects covered are: uses of industrial water; difficulties caused by water in industry; composition of industrial water and water-formed deposits; treatment, sampling, and analysis of industrial water; sampling, identification and analysis of water-formed deposits. The appendix lists all ASTM standards relating to industrial water for sampling, analysis, reporting of results, methods of testing; and includes a glossary and bibliography of ASTM publications on industrial water. Philadelphia, American Society for Testing Materials, 1956. 502p., $6.00 (U.S.).

MATERIALS AND PROCESSES IN MANUFACTURING

Written for undergraduate engineers who do not intend to enter the fields of either metallurgy or machine tool design, this volume describes the materials and processes used in manufacturing.

The section on materials shows how and why any particular material is used for a specific application, and includes chapters on metals and alloys, heat treatment, alloy steels and irons, non-ferrous alloys and plastics.

The processes described in detail are casting and forming, machining, welding, brazing and soldering. A final section considers actual manufacturing and covers such topics as layout, jigs and fixtures, surface treatments, mass-production tools and techniques and the planning of manufacturing operations.

A useful bibliography concludes this work which may be used equally well for an undergraduate text or a refresher for the practicing engineer. E. P. Degarme. Toronto, Brett-Macmillan, 1957. 755p., $8.75.

*THE MECHANISM OF PHASE TRANSFORMATION IN METALS

Included in this publication are eighteen papers delivered at a symposium held in November 1955. The papers are in two groups, one dealing with nucleation and growth processes, the other consisting if papers on martensitic transformation. Each group contains a general review paper followed by papers describing original research on specific problems; precipitation in lead-tin alloys; superlattice formation in the alloy CdM-33; the allotropic transformation of cobalt; the bainite reaction in high-carbon steels; and so on. A subject index is provided. London, Institute of Metals, 1956. 346p., 50/-.

METHODS OF BOOK DESIGN

Book design is defined as the planning which determines the physical qualities of the book, and in this volume the reader wll find information on every aspect of the subject, starting with the preparation of typescript. The author discusses format, composing machines, choice of type and the varieties of type, text design, preliminary pages, printing processes, colour, illustrations, the binding, and the jacket.

The author received his training at the Oxford University Press, and is now production manager of a large publishing house. The book is admirably illustrated and produced, and is highly recommended to authors and publishers as well as to those readers who are interested in the production of their books. Hugh Williamson. Toronto, Oxford University Press, 1956. 430p., $9.00.

MODULAR CO-ORDINATION IN BUILDING

This is a report of the first phase of a project undertaken by a team of ex-

perts from eleven countries to develop a method of co-ordinating the dimensions of building materials.

The first phase of the project involved the discussion of theories of modular construction, and of the methods to be used in carrying out the second phase, the actual erection of buildings.

The first part of the report, design, discusses the reference grids and the size of the module. The second covers the size of the various building components while the third describes the use of grid lines and the location of components relative to the grid line.

This is, in effect, the latest textbook on modular co-ordination and as such will prove extremely valuable. Organisation for European Economic Co-operation. Toronto, Ryerson, 1956. 168p., $1.50.

*OXYGEN IN IRON AND STEEL MAKING

A review of previously published information, together with the results of some unreported trials made by British iron and steel making companies. About half of the contents is devoted to the treatment of molten metal — the desiliconization of iron; oxygen in the Bessemer process; oxygen injection in the open hearth process; the use of oxygen in the electric arc furnace for the production of stainless steels, and the effect of oxygen treatment on metallurgical properties. The remainder of the book is concerned with flame-enrichment and with blast enrichment as applied to the blast furnace, the cupola, and the gas producer. J. A. Charles, W. J. B. Chater and J. L. Harrison. Toronto, Butterworth, 1956. 309p., $6.50.

*PATENT NOTES FOR ENGINEERS, 7th ED.

This is a discussion of the practical problems that arise from the moment of conception of a patentable invention to the acquiring of patent rights. Illustrated by numerous cases and examples, the discussion covers invention as defined in patent law; the need for good records and adequate disclosures; the preparation and prosecution of applications; and the ownership and use of patents. C. D. Tuska. Toronto, McGraw-Hill, 1956. 192p., $4.80.

THE PHYSICS OF FLOW THROUGH POROUS MEDIA

Based on a bibliography compiled by the author some years ago, this volume summarizes available information on the physical principles of hydromechanics in porous media, information which has not previously been collected in one text.

As over two thousand references were collected, some selection had to be made, and emphasis was therefore placed on the general aspects of the subject rather than on particular cases, and theoretical aspects have been stressed more than experimental ones. Also, only one solution has been presented for some of the basic differential equations, even though many may have been available.

The topics covered include the properties of porous media and fluids, Darcy's Law, the physical aspects of permeability, general flow equations and multiple phase flow. Throughout the book, the emphasis is on the flow of homogeneous, single phase fluids, as most applications are concerned with these. There is a twenty-four page bibliography, keyed to the different chapters.

The author is now a geophysicist at the Dominion Observatory. A. E. Sheidegger. Toronto, University, Press, 1957. 236p., $13.50.

STATISTICAL QUALITY CONTROL

This publication of the European productivity agency of the Organization for European economic co-operation includes the attempts of the agency to introduce statistical quality control to nations other than the United States, where it is practiced extensively. Contents includes an account of the work done in various European countries in connection with this project; an introduction to modern techniques in the field written by an American expert, P. C. Clifford; accounts of two conferences held in Paris in July

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DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

1955 in which the present state of development of control techniques in Europe was reviewed and a number of the recommendations made. Paris, O. E. E. C., Toronto, Ryerson, 1956. 89p., 75c.

SURVEY OF MINES, 1957

This thirty-first annual survey of the Canadian mining industry gives detailed information on the companies active in Canada including current earnings, finances, ore position and production, directors, dividend performance, subsidiary connections and inter-company holdings.

There are twenty-eight pages of maps of the principal mineral areas, price ranges of stocks over the last eight years, and mineral production tables.

This survey is a must for all those with money to invest in Canada's expanding mining industry, and for those connected with it in any way. Toronto, Financial Post. 1956, 392p., maps, $3.00.

TUNNELBAU

Modern methods of tunnel construction are described for both the practicing engineer and the student. The major part of the book is devoted to the simpler types of tunnels and tunnel construction, with separate sections on subaqueous work, subway construction, and tunnel breaks and repairs. There is a brief chapter on the history of tunneling operations. Carl Aussendorf. Berlin, Verlag Technik, 1955. 312p., illus., DM 33.00.

YEAR BOOK OF THE HEATING AND VENTILATING INDUSTRY, 1956

The articles included in this 1956 edition cover oil firing, panel heating, and the electric surface heating of fuel oil lines and storage tanks. Other sections give: an index to heating and ventilating literature, list of British standards, legal and labor agreements covering the British heating and ventilating industry The classified buyers list and manufacturers directory comprise about one half the volume. London, Technitrade Journals, 1956. 398p., 10/6.

TECHNICAL BULLETINS AND PAMPHLETS RECEIVE[D]

Bridges

The evaluation of highway bridges. D. T. Wright.

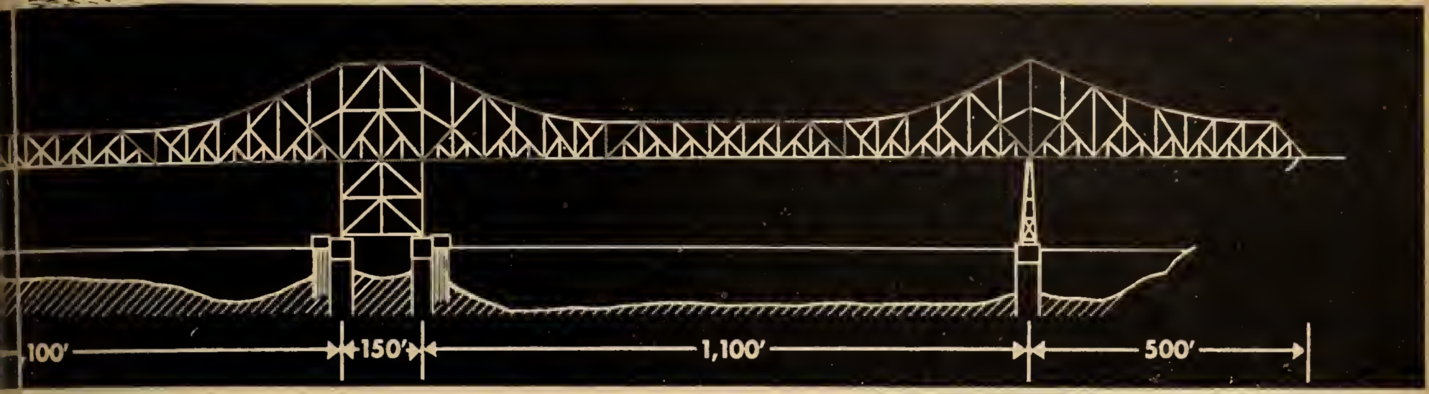
Proposed specifications for the ratin[g] of existing bridges. D. T. Wright. (Kingston, Queen's University, Reports No: Q6-1 and Q6-2.).

Concrete

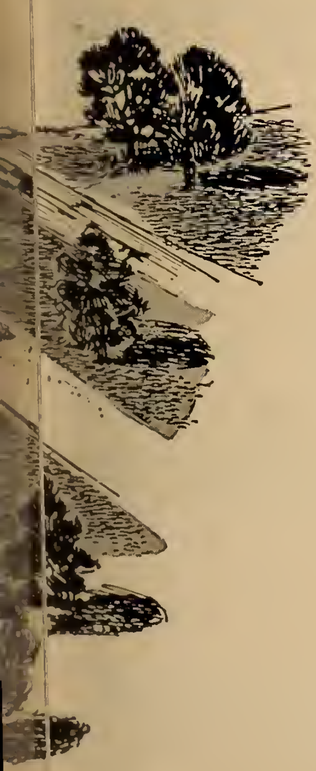
Calculation of stress from strain i[n] concrete. K. Jones. (U.S. Dept. of th[e] Interior, Bureau of Reclaim. Tech. Mem[o] 653.).

Tests on the old dental hospital, Jo[-] hannesburg. General report. A. J. Ockl[e]

NEARLY 500 of the more than 1,000 gusset plates and 142 of the 664 truss members in the new bridge were made from USS "T-1" Steel. The weldability and very high strength of this remarkable alloy steel saved weight, time and money.



WILL SAVE $800,000 IN FIRST MAJOR BRIDGE APPLICATION



Next year the State of California will open a new toll bridge paralleling an existing structure across the Carquinez Straits. This will be the final step in a mammoth project underway to relocate some twelve and a half miles of very busy highway connecting the San Francisco Bay Area with the Sacramento Valley.

The new $20-million bridge will be unusual. While, in appearance, it is a near carbon copy of the present structure across the busy straits, it will employ some 2,900 tons of USS "T-1" Steel in its most highly stressed truss members. Of 664 members in the trusses, some 142 will be of welded construction and made of "T-1" Steel.

The weldability and 90,000 psi minimum yield strength of USS "T-1" Steel will dramatically simplify design and fabrication of critical members. Take one example, a lower chord member: In the new structure, it will be made from just five welded plates of "T-1" Steel and require 340 feet of 5⁄16" automatic fillet welds. But, had it been put together by stitch riveting, the method used in the original span, this same chord member would have required *eight* vertical plates, *four* angles, and *two* cover plates . . . plus *1,000* rivets and *3,600 punched and reamed holes!*

Besides ease of fabrication gained through welding, "T-1" Steel's tremendous strength permits big weight savings. For example: one of the top chord members of the new bridge will weigh 400 lbs. per ft. and have a section area of 117.19 sq. in. A structural carbon steel (ASTM A-7) member for the same location would weigh 996 lbs. per ft. and would require a section of 293 sq. in. Lighter, smaller members mean reduced moment of inertia and important reductions of secondary stresses.

According to design computations by the State of California, USS "T-1" Steel will save approximately $800,000 in building the new Carquinez Straits Bridge—the first major bridge application of this remarkable constructional alloy steel.

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For More Information—Write on your company letterhead for our newly revised, comprehensive booklet entitled "T-1." In it, you will find a wealth of engineering and metallurgical data. United States Steel Export Company, Royal Bank Building, Toronto 1, Ontario.

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TORONTO · MONTREAL · WINNIPEG · WINDSOR · CALGARY · VANCOUVER ston. Paper No. 1. The determination of the properties of materials from the old dental hospital. A. J. Ockleston and I. R. Scott. Paper No. 2. Effect of floors and walls on the behaviour of reinforced concrete frameworks subject to horizontal loading. A. J. Ockleston. Paper No. 3 (All: Johannesburg, The Concrete Assoc.

Electrical Engineering

Asta Assoc. of Short-circuit Testing Authorities Inc., Pub. No. 1, 1956 rev.).

The Electrical Research Association. Technical reports: F/T184–A simple method for the calculation of cyclic rating factors for cables laid direct or in ducts. H. Goldenberg. L/T324–A comparison of ionization energies of trapped electrons in ionic solids using the static model. J. H. Simpson. L/T327–Stabilization of impregnated-paper capacitors: further pilot scale tests with azobenzene. H. F. Church. M/T120–A simple and versatile R.F. mersuring circuit. J. Miedzinski and S. F. Pearce. M/T121–The properties and design of iron-cored suppression chokes. J. Miedzinski. O/T14–Choice of insulation and surge protection of overhead transmission lines of 33 kV and above. A. Morris Thomas and D. F. Oakeshott. S/T94–Lightning protection of tropical transmission systems. R. H. Golde. Z/T98–Pole-face losses in rotating electrical machinery. A review of the state of the art. K. C. Mukherji.

List of articles, books and reports on electrical shock and correlated subjects. W. MacLachlan.

Principal hydro-electric and hydraulic developments in Canada with turbine capacities not less than 2,000 H.P. (Canada. Dept. of Northern Affairs and Nat'l Resources. Water Resources Br. Bul. No. 2565.).

Supplement to the bibliography and abstracts on electrical contacts, 1955.

Symposium on minimum property values of electrical insulating materials (A.S.T.M. s.t.p. nos. 56-J and 188).

Geography. Canada

Extracts relating to the navigability of Canadian inland waterways. W. A. Black. (Geographical paper No. 7.).

Notes on potential building sites in the Bathurst Inlet area, N.W.T., J.B. and M. B. Bird. (Geographical paper No. 8.).

Selected bibliography of Canadian geography with imprint 1955. (Bibliographical series No. 17.).

(All: Canada, Dept. of Mines and Technical Surveys, Geog. br.).

Industrial Relations

The benefit formula in unemployment insurance. M. T. Wermel. Calif. Inst. of Tech., industrial relations sect'n, BIRC Pub. No. 5.).

Requirements for professional personnel, 1956-58. (Canada, Dept. of labour, Unemployment Insurance Commission.).

Metallurgy

Photographic aspects of weld radiography. L. Mullins (British Welding Research Assoc.).

Structural chemistry and metallurgy of copper. D. K. Crampton. (A.S.T.M. Gillett lecture, 1956.).

ENGINEERING CAREERS

The Opportunity for Professional Engineers in Education

THE THESIS that all mankind can be divided into two groups as "those who do" and "those who teach" has sometimes been frivolously proposed. The implication being that those who do the one are either unwilling or unable to do the other! Admittedly this has been the prevailing condition in the majority of both business and educational institutes in the past. Schools of business administration, utilizing the case-study method, and schools of field engineering, using practical problems, are indicative of the current and altered philosophy of education. A proven ability "to do" has been established by many of the country's educational institutes as mandatory for appointment to the teaching staff. Beyond this, and perhaps more important, a peculiar combination of circumstances both forces and permits the instructional staff to work each year in their chosen field within the world of business.

It is particularly recognized in connection with applied science (engineering), that technological advance is best made when there is a contemporary development of theory and practice. Combine with this the authority that accomplishment bestows upon a teacher, and the professional engineer engaged in education can be considered as occupying a somewhat unique and favoured position.

The Canadian School Structure

The subjects usually taught in schools above the elementary level may be conveniently divided as

(a) Non-professional subjects (e.g. trigonometry)

(b) Professional subjects (e.g. surveying.

Differentiation is made on the basis that application of knowledge of the first type of subject by itself would not normally be of economic value, while proficiency in the latter has a realizable value.

With some training pedagogy an engineer may be thoroughly qualified as an instructor in the non-professional subjects, and may frequently find rewarding employment in such a field. His own professional training however adds little distinction to such an encumbency. Of primary interest then is the engineer's occupation as a teacher of professional subjects. In Canada the technical education facilities are found within four types of schools; each having a special purpose and therefore offering different opportunities to the engineer-teacher.

High schools serve as continuation schools to the elementary education system. Collegiate high schools present chiefly non-professional courses, and are preparatory for admission to the universities. To all the subjects taught in these schools the engineer may contribute an emphasis of practical application which is invaluable in capturing student interest. Vocational and technical schools operate at the same level but are concerned with elementary trades training. Teachers having practical trades experience augmented by professional training should be of value in raising the standard of material presented by such institutions.

Technical colleges and trades schools are the advanced level counterparts of the collegiate and vocational schools. The technical colleges may serve as finishing schools qualifying men for junior and intermediate grade professional work. Frequently they are but the first phase of a full professional training. Trades schools give completion training of the highest order in the skilled trades. Both of these types of schools are of increasing necessity and popularity in a country having a dispersed but growing population. Consequently these schools offer the widest opportunity for engineers seeking to enter the teaching profession.

The Royal Military College is one of the Canadian Services colleges operated by the federal government, which offers an integrated military and academic program of the highest calibre. Because of the diverse needs of the three defence services a very broad engineering training is given, and the graduates of R.M.C. are generally required to take the final year of the engineering course at a university to obtain full professional status. At this college the academic instructional staff are either civil servants or military personnel.

The Present Opportunity

Virtually all of the universities in Canada are engaged either in the expansion of their engineering faculties or in the establishment of these. Besides the demand for instructors to accommodate increased enrolments there is the more difficult-to-satisfy need for men with specialized training capable of teaching the many new subjects which are yearly added to the curriculum. Typical of such subjects are business administration, soil mechanics, nuclear power, and aeronautical engineering.

Every mature engineer realizes a sense of gratitude to some senior engineer who has made an invaluable contribution to his own professional development. It has been said that "It takes an engineer to make an engineer"; perhaps this is the most pertinent in the academic phase of an engineer's training.

This article was prepared by D. A. Selby, Assistant Professor, Civil Engineering Department, McGill University.

By way of illustration of the entrance and progress of an engineer within education, three case histories involving men currently teaching in one of the larger universities can be cited.

Case 1. "A" had a background of considerable experience with an engineering firm before entering college. He graduated with a Bach. Eng. degree in 1949. Thereafter he remained at the university to do graduate studies to obtain his Masters degree. "A" was then appointed a lecturer and in 1954 was promoted to Assistant Professor. Currently he is lecturing in intermediate level professional subjects and in advanced non-professional subjects.

Case 2. "B" also graduated in 1949 but joined the staff of a large corporation and obtained considerable experience in several engineering departments. By 1956 he had attained the lower level of management category but resigned to accept the appointment of Assistant Professor.

Case 3. Engineer "C" had graduated in 1939 and had been employed until 1946 in design engineering work for a large company. "C" returned to university then to do graduate work for the degree of M.Eng. There followed appointment to the staff as a lecturer (1947), then promotions to Assistant Professor (1951), and Professor (1957).

Quite obviously the advancement of these men was comparable with that occasioned within industry during the same period. The cause for this advancement being identical in both spheres is an expanding economy and an advancing technology.

Opportunities for Professional Activity Contingent with Teaching Duties

Traditionally and naturally the university should be the centre of research and hence the origination point of scientific progress. Regrettably some measure of this leadership has been lost to industry due to the latter's potent and proper proprietary interests. Nevertheless the atmosphere of an institute of learning is conducive to advanced thinking and scientific investigation. Thus the engineer in the teaching profession has frequently the means, within himself, and the opportunity, within the university, to conduct research of the purest scientific purpose. Frequently this research is advantageously sponsored by one or more interested commercial bodies.

Only in private consulting practice does the engineer assume his full professional capacity. It is only reasonable then that at some time, every engineer will yearn within himself for the role and deserved title of consulting engineer. However the realization of this is more difficult. To require the necessary ability, confidence and reputation required for an independent practice which will provide remuneration equal to the current salaries in industry, normally requires many years of intensive work. The significance in this respect of a working engineer's appointment to a professional post is immeasurable. There is immediately created an enhanced professional standing based on confidence, and an expectation that the subject engineer will keep himself fully informed of contemporary theories and developments.

Compensation

The direct remuneration received from the colleges and the universities does not compare with what the same engineer could receive from competitive industry. Even overlooking salaries offered by industry to engineers with seven to fifteen years' experience, a comparison of the salaries cited in the accompanying tabulation with amounts currently being offered to the members of the graduating classes this year ($4,800-$6,000 per annum) makes this plainly apparent.

Significant Salary Figures from Ten Canadian Universities ($ per annum)

	Lecturer	Assistant Prof.	Assoc. Prof.	Professor
Average	5,000	5,840	7,320	8,590
Low	3,500	4,500	5,120	5,700
High	7,000	8,500	11,500	12,000 and up

However there are some compensating considerations. The first of these is the opportunity for obtaining supplementary income from a consulting practice. Then there are some so called "fringe" benefits such as some social distinction within the community (of uncertain significance at times) and the extended summer vacation.

Intrinsically however there are three powerful factors which attract men to, and hold them in, the teaching profession.

The first of these is a real sense of freedom of activity not commonly enjoyed by the servants of industry. The academic freedom essential for the advancement of learning is but one aspect of this. At the same time it would be grossly incorrect to assume that the engineer-teacher has a large amount of leisure time. To the contrary, he is usually extremely busy but the majority of his activity is subject to his own election and organization.

The second of these factors is the large measure of job satisfaction associated with teaching. This arises from several causes including the full utilization of one's own training, and the constant need and facility to keep current with technical development.

Akin to, and part of, this job satisfaction is the genuine thrill of teaching that is experienced by a teacher. Perhaps this is but the realization that by education one makes a contribution to society that has the capacity of expanding itself geometrically. From another aspect it may be that satisfaction of a natural urge for reproduction—in this case—of one's professional personality.

To summarize it all—a sincere teacher must be a dedicated man—and there is a manifest satisfaction in being a dedicated man.

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Contents - June 1957

(18,250 copies of this issue printed)

Message from the President

NEVER BEFORE in the history of the world has there been a period requiring such momentous decisions as those which must be made today.

Hitherto slumbering peoples in vast numbers, living in crowded areas, are awakening to demand their rights to better living. Those peoples who have already achieved a relatively prosperous way of life have ambitions to attain a better.

Jealousies between nations and ideologies have never been so pronounced, nor fraught with the possibilities for such evil consequences.

Yet all these difficulties, these ambitions, these jealousies are susceptible to solution and, with God's help, that solution will be found.

As engineers living in a world so dependent on science and its application, we have an ever increasing responsibility to play our part in building the foundations, and on them the structure by means of which we are to reach that solution and make it secure. Too many people are depending on the engineer to lead the way, to permit of failure.

That I have been accorded the privilege of being selected by my fellow engineers to preside over the affairs of the Institute for the ensuing year makes me proud and humble. I am indeed grateful for the privilege, and with the example before me of those who have preceded me in in this high office, and with your understanding and help, I will endeavour to justify your selection of me for the honour which I prize so highly.

C. M. Anson, M.E.I.C.
President

Some Engineering Problems in Connection with The Industrial Application of Nuclear Energy

Sir Claude D. Gibb, K.B.E., F.R.S.

Chairman and Managing Director, C. A. Parsons and Co., Ltd.

The forty-third Thomas Hawksley Lecture delivered to the Institution of Mechanical Engineers, February 1957, and subsequently to meetings of E.I.C. The paper is reproduced here by arrangement with the Institution.

AN INVITATION to deliver a Thomas Hawksley Lecture is an honour which, onerous though it be, is not lightly refused. When that invitation permits the setting down of some of the engineering problems uppermost in the minds of many scientists and engineers in the past few years, it is accepted with considerable appreciation.

These notes were prepared at a time when the Middle East territories were sorely troubled and the major nations of the world sharply divided. But the outcome of those international problems do not affect the basic fact that Great Britain has faced, and is today facing, the urgent need to develop the industrial application of nuclear energy almost as a matter of national salvation.

Power, and more power, in the service of man in industry and in his home, is the only way by which we can improve living standards in Britain or elsewhere in the world. Outstandingly the most easily applied and transported form of power is that provided by electricity. These are facts demonstrable beyond dispute.

Those nations of the world — and those families within a nation — who have the highest consumption of electricity per head, also have the highest living standards. Those nations who have the greatest rate of increase in electricity usage, also have the highest rate of increase in living standards. Hence it can be stated with certainty and conviction, that in Britain and elsewhere in the world, the greatest single factor in increasing national industrial productivity is an ever-increasing use of electricity per man in industry. For Britain, dependent as she is for existence as a major nation upon the quality and competitive price of its exports, this increase in electricity usage is of paramount importance.

In the past fifty years in Britain, the consumption of coal per unit of electricity produced has fallen from about 4 lb. to under 1 lb. But in that same period the consumption of electricity per head of population has increased by almost thirty times and shows no signs of ceasing to increase. Our consumption of coal for electricity production has doubled, trebled, and quadrupled. But our total annual production of coal has fallen by some 25 per cent and today is in short supply to the extent that we have changed from an exporting to an importing coal country. The reasons for this are fairly obvious and were and are inevitable. By a huge sum of capital investment there may be some increase of coal production but not by any means sufficient to meet the ever-growing need for more fuel to produce more electricity.

Ten per cent of all our industrial production is now based on oil. Transport, aviation, farming, the fighting Services all depend upon oil. World oil demand by 1965 is expected to be 70 per cent higher than it was in 1955. In those ten years American production is expected to increase 30 per cent, other Western Hemisphere production 70 per cent, and Middle East production by over 150 per cent. Will Britain have the dollars to purchase American oil in any increasing quantity? The answer is an emphatic 'No'.

Oil will be essential for so many industries and services that the ever-continuing threat to our oil supplies from the Middle East will demand the husbanding of such oil as we can obtain for those uses where there can be no alternative.

Until the Calder Hall Atomic Power Station demonstrated to the contrary, the large-scale production of electricity — other than from hydro power — was considered to require either coal, oil, or natural gas as the primary fuel. Coal we know will not be available in sufficient quantities to provide all the electricity we must have. Gas we have not. Dare we rely upon oil as a complementary or substitute fuel? Only as a matter of expediency and then only because there was no alternative should we, as a nation, become dependent upon oil to the extent that further wars become inevitable in preservation of it.

An alternative fuel to coal and oil in the production of electricity is today available. It is on the engineer, much more than on the scientist, that the future of Britain and the world depends. The scientist will devise new methods for the more efficient utilization of nuclear fuels and the engineer will apply them. And it will be primarily the mechanical engineer who faces the great challenge to the nation and the world today.

In a series of outstandingly valuable papers read before the British Nuclear Energy Conference some three months ago, the researches, investigations, and considerations which preceded the final designs of the Calder Hall Nuclear Power Plant were outlined by those engineers and scientists who were so intimately concerned in that great project. Some of the considerations leading to the final design decisions were economic, and some of expediency dictated by availability of supplies and materials. Had there been more time available to conduct further researches—time to study other alternative types of reactor; consider other moderators, other coolants—would the final decision have been different? I believe not. Intuition amounting to genius played a major part in those final decisions which now have been proved to have given Britain a commanding lead in the development of nuclear energy in the service of man.

So much has been spoken, written, and published on the subject of nuclear energy, that it is now well known that a nuclear reactor is merely another source of heat capable of being harnessed to produce steam which, by means of a more or less orthodox turbo-generator, develops power in the form of electricity. The key to the industrial development of nuclear energy is the reactor and the means adopted to transfer the heat released during nuclear fission into the steam required to drive a steam turbine. It is not at present believed to be possible to generate power economically by nuclear fission except through the medium of the steam cycle and, since this lecture is to be concerned with engineering problems, it is not proposed to theorize on hypothetical reactors of the future.

Reactors available today may employ as fuel either natural or enriched uranium. The moderator, necessary in thermal reactors to slow down the neutrons and make them more effective may be graphite, heavy water. or ordinary light water. Beryllium need not be considered at this stage since it is not available in quantity and is too costly for large-scale use. Light water demands some degree of enrichment for its fuel and the engineering problems are very great if it is to be used as a moderator for industrial large-scale power generation.

The essentials of any system for electricity generation are well established and may be stated as:

(1) reliability of the highest possible order with its consequential high availability of supply;

(2) minimum cost per unit of electricity delivered for sale, this covers capital and fuel and maintenance costs per unit;

(3) minimum of nuisance from smoke, dust, effluent, or other factor likely to cause opposition to the siting of the power station in a location most favourable for minimum transmission costs.

If the power station employs steam turbines then large quantities of condenser cooling water are required but this condition must be met regardless of the fuel used.

The need for reliability is obvious since if there are doubts regarding the plant availability when power is required, then standby plant must be provided at increased capital cost which must be charged against the unreliable plant. This factor leads to a philosophy of design which must determine and dominate all stages of research, development, and construction in nuclear as in orthodox power stations.

Safety is inherent in reliability and also will play an important part in deciding on the siting of a nuclear power station, since if there is any possibility of danger arising during its construction or operation there will be opposition to any site near a load or population centre thus increasing transmission costs. Hence the selection of Dounreay, in the far north of Scotland, for the siting of Britain's first large-scale fast-breeder reactor until it is known for certain that its many engineeing problems have been solved with resulting absolute safety. The fast-breeder reactor may be considered to be the ideal reactor offering the greatest fuel economy at present envisaged and, after many years of development, may well play a major part in future industrial nuclear power. It is not, however, at present available for use in Britain's urgent need.

In recent years, Britain has become less than self-sufficient in fuel resources. Enough cheap coal is no longer available; the economic supply of petroleum fuels is uncertain. Britain has, therefore, to develop the commercial production of electric power from nuclear fuels sooner and perhaps less economically, than may be obtained elsewhere. Few people are better qualified to discuss the engineering problems connected with such a project than the present author.

Enriched uranium is not available at present and, while the international situation remains unsettled, will not be available in quantity for industrial purposes. In any case, enriched uranium is what Sir Christopher Hinton has rightly called it, namely, 'potted electricity' since the major cost item in its production is that of the electrical power used to drive the compressors in the diffusion plant. Since electricity costs are higher in Britain than in the United States of America and Russia because of higher coal and oil costs, it is obvious that British produced enriched uranium would not be competitive in world markets as a fuel. Thus, because enriched uranium has not been, and is not now, available, the British nuclear power programme had perforce to be based upon natural uranium as the fuel. Perhaps we were fortunate in this respect since the field of research and design was narrowed and diversity of effort thereby avoided.

Similarly with considerations of using heavy water as a moderator. Thinking only in terms of neutron economy — and this is very necessary with natural uranium as the fuel — heavy water is an excellent moderator, superior to, but costing some one hundred times as much as, graphite which was available readily whereas heavy water was not. A major cost item in the preparation of heavy water again is the considerable amount of electricity used in its production and thus Britain could not produce it competitively.

The factors of availability, cost, and expediency, almost forced the decision to proceed with the Calder Hall project on the basis of natural uranium with graphite as the moderator. When the cooling medium came to be settled, here again expediency provided the same answer as the engineering and economic considerations and dictated carbon dioxide gas as the coolant. This almost makes it appear as though the designers had an easy task in making these decisions. Let me assure you that this was not so. The brilliant deductions leading to the final selections were outlined in a factual but quite excellent series of papers read before the British Nuclear Energy Conference in November 1956.

What is important to Britain as a nation, to its electricity supply industry and to British industry generally, is that those decisions taken by Hinton, Owen, Moore, and their colleagues, have produced in the Calder Hall nuclear power station a model which is the envy of the world. British industry, trained and given experience by the United Kingdom Atomic Energy Authority, and in collaboration with them and the Central Electricity Authority and the South of Scotland Electricity Board, has produced advanced designs based upon and developed from Calder Hall, which have now commenced or are about to begin construction. The designs are 'optimized' for electricity production and comply with the criteria outlined earlier. Figs. 1 and 2 are typical of the completed appearance of such a nuclear station, which because it makes a complete break with tradition in the fuel used and in the absence of smoke, dust, grit, or other nuisance, has enabled an equally complete change to be made in architectural design and appearance. It will be noted that the heat exchangers or boilers are enclosed, which was not the case at Calder Hall seen in Fig. 3. It was considered that the additional cost involved at least balanced the simplification of maintenance and the avoidance of frost problems on drains and small-bore pipes, and of course it improved architectural appearance.

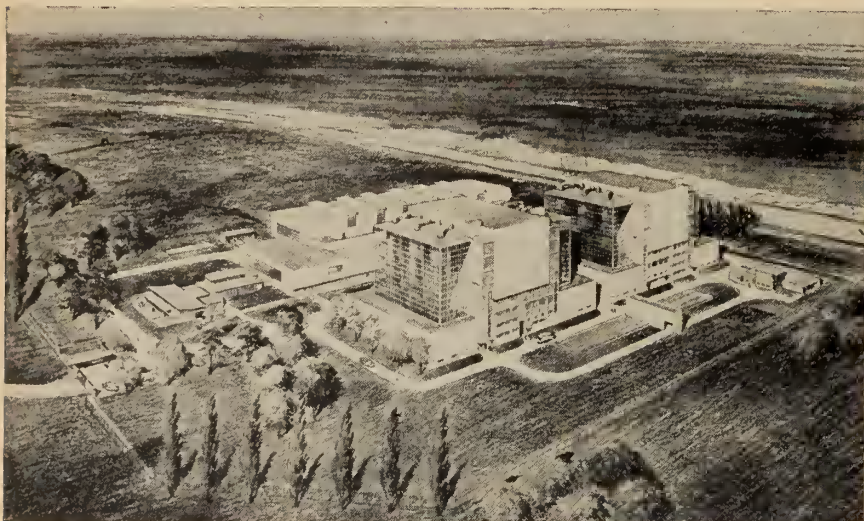
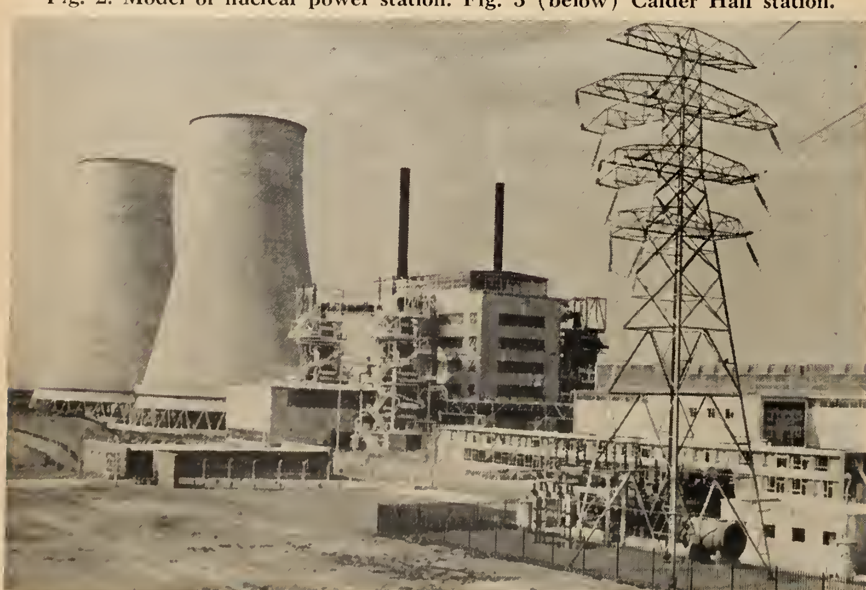


Fig. 1. Artist's impression of nuclear power station.

Fig. 2. Model of nuclear power station. Fig. 3 (below) Calder Hall station.



It will be evident to all engineers that, just as the boiler size and the amount of fuel consumed per day in an orthodox coal-fired or oil-fired power station determines the electrical output, so also does the reactor, its dimensions and fuel burn-up rate, determine the output in a nuclear station. Hence the nuclear physicist and the turbo-generator designer must work hand in hand at every stage of design and development. But in between reactor and turbines are the equally interdependent circulators, ducts, boilers, and auxiliaries. Of at least equal importance to all these plant items is the concrete shielding surrounding and encasing the reactors, which calls for great experience in design and construction to ensure safety for the operators against radiation effects. There are few, if any, engineering projects which demand such close co-operation between such a wide range of scientists and engineers, each a specialist in his own field.

THE REACTOR

Nuclear calculations for a natural-uranium, graphite-moderated, gas-cooled reactor are extremely complex and are greatly simplified and speeded up by the use of a special form of analogue computer for determining the power reactivity relationship of the core. Fig. 4 shows such a computer.

Nuclear physicists will state the minimum size of core and the amount of uranium to obtain criticality, and from this information and considerations of fuel rating the output expressed in megawatts from varying core dimensions may be determined. Fig. 5 shows a typical relationship. It will be appreciated that an increase in the core size above the critical pays a handsome dividend due to reduced leakage and the possibility of flattening by the introduction of an absorber thereby increasing the mean rating of the fuel.

The maximum rating of the fuel in the centre channel of the core which very largely sets the seal on the reactor economy is determined by the maximum temperature permissible in the fuel rod and the can. These must be determined by the thermodynamicist and the metallurgist working in the closest collaboration.

These factors largely determine the mass flow of the gas and its inlet and outlet temperatures.

The heat exchanger or boiler designer must now decide how much steam, and at what pressures and temperatures it can be supplied to the turbines, whose designers then provide a figure for electrical output. The designers of the duct work and gas circulators then determine the pressure drop in reactor, ducts, and boilers and, with a known mass flow, can design their portions of the plant.

But, during this preliminary study, the designers of the shield around and above the reactor have been calculating the amount of protective concrete and other materials required to limit radiation hazards, and their requirements certainly will affect the civil engineering and duct work layouts thus calling for design modifications. Many trial and error calculations are necessary before even semi-finality is obtained.

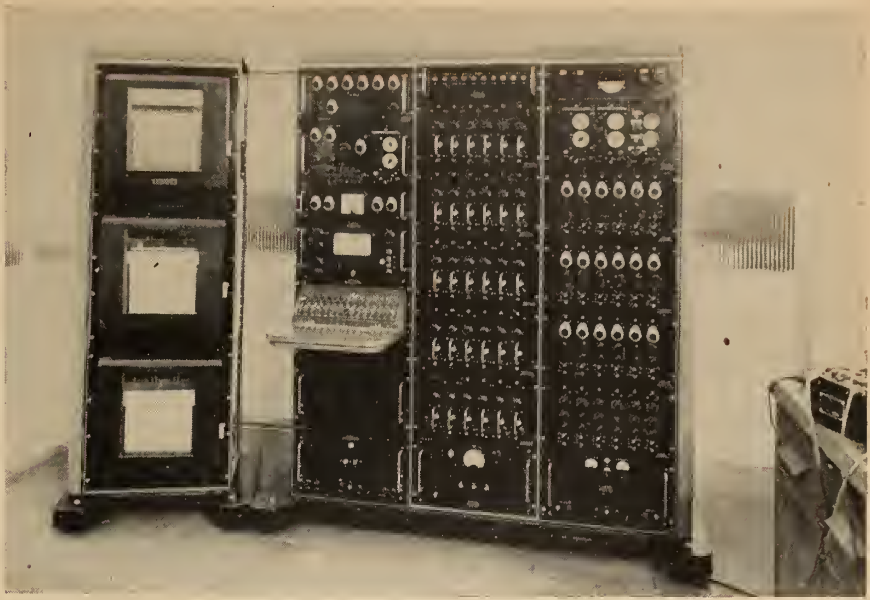


Fig. 4. Analogue computer.

No mention has yet been made of the reactor pressure-vessel designers whose experience, views, and potentialities are vital to final design decisions. Once the pressure-vessel designer has been given a preliminary estimate of the reactor-core dimensions, he can consider whether to use a cylindrical vessel as at Calder Hall, or a spherical vessel which so obviously is to be preferred if considered purely as a vessel to contain gas pressure. But he must consult the designers of the fuel element charging and discharging gear, because that mechanism requires certain space above the reactor core and also almost riddles the crown of the pressure vessel with holes or tubes to provide access to the fuel channels. The pressure-vessel designer must also know the dimensions of, and how many, ducts carrying the gas have to be brought into the reactor shell. He must also consider how to transmit the very considerable weight of graphite and uranium through the vessel to the foundations without complicating and increasing locally the stresses resulting from the gas pressure. That harassed designer also has to consider the changes in temperature between inlet and outlet gases and the stress pattern induced in consequence, and then face the crowning problem of the irradiation effects upon the shell materials available to him.

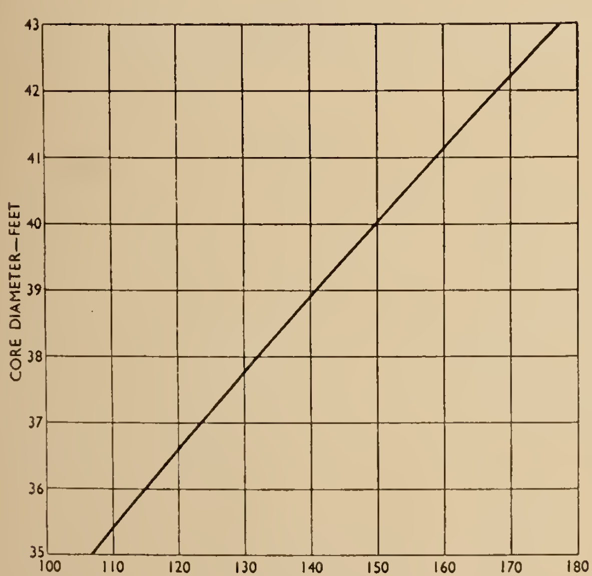


Fig. 5. Core diameter and net electrical output.

The higher the gas pressure the vessel designer can allow, then the greater the heat transfer from uranium through the can to the gas; the smaller the mass flow required for a given heat quantity removed and the lower the power needed for gas circulation which thus increases the net electrical output from a given quantity of uranium. This auxiliary power used for gas circulation is particularly important in nuclear station design, since it may take some 10 per cent of the total potential useful power output of the reactor. It is the possibility of raising the net power output by reducing auxiliary power (and also raising the temperature of the cooling medium outlet with its improved steam-cycle conditions and efficiency) that has turned the attentions of so many designers to the liquid-metal-cooled graphite-moderated reactor.

But, for the generation of electricity for normal industrial use, it is essential that the changing of fuel elements should be done without affecting the electrical demand on the station. Changing fuel elements in a gas-cooled reactor is relatively difficult and calls for ingenious, costly, and massive charge and discharge machines which now are available. The problems to be solved in changing fuel elements with liquid-metal cooling whilst the reactor is on load are much greater and, when allied to the determining of faulty fuel elements, will call for exceptional ingenuity. This is one of the engineering problems awaiting an elegant solution and, when solved, will simplify reactor-vessel design and lead to a marked improvement in fuel efficiency provided that the canning material allowing higher temperature does not nullify its advantages by absorbing too many neutrons or costing so much more than aluminium or magnesium oxide as to increase the cost of a unit of electricity produced.

The designer of industrial nuclear stations must never lose sight of his prime object which is to produce electricity at the lowest cost possible consistent with safety and reliability. There are so many solutions to nuclear power problems that appear to offer advantages in one or other direction, but always either at the expense of safety or of generating cost so that they provide pitfalls to be avoided.

Fig. 6 is a typical curve of capital cost per kw. of output plotted against net electrical output for a particular design of gas-cooled reactor, and shows how the capital cost falls with output. In practice the curve would be in a series of steps corresponding (amongst other factors) to steps in the reactor-vessel wall thickness. But the reactor vessel for outputs of all possible designs using natural uranium, necessitates at least final welding on the construction site and this limits the thickness of the pressure vessel to that which can safely be site welded, and this in turn limits upper gas temperatures because of metallurgical considerations.

The Calder Hall reactor-vessels were of 2-inch thick special mild-steel plate but subsequent research and experimental weldings have shown that site welding of 3-inch plate is now possible and, with further experience, still thicker plates will be used in future with corresponding increases in pressure and efficiency. To change from the vertical right cylinder vessels as at Calder Hall to spherical vessels enabling higher gas pressures to be adopted, necessitated finding solutions to many problems, not the least being the sealing of inlet and outlet gas paths from the walls to the core, doing this without adding appreciable temperature stresses to the already pressure stressed walls.

A fundamental philosophy of design in nuclear reactors should be never to put anything inside the vessel which has to move yet which cannot be removed and replaced once the reactor has been to full

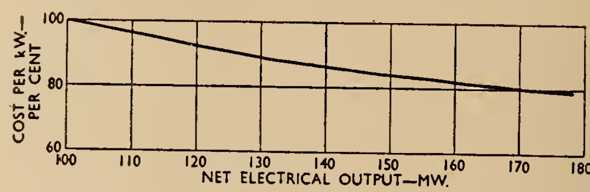
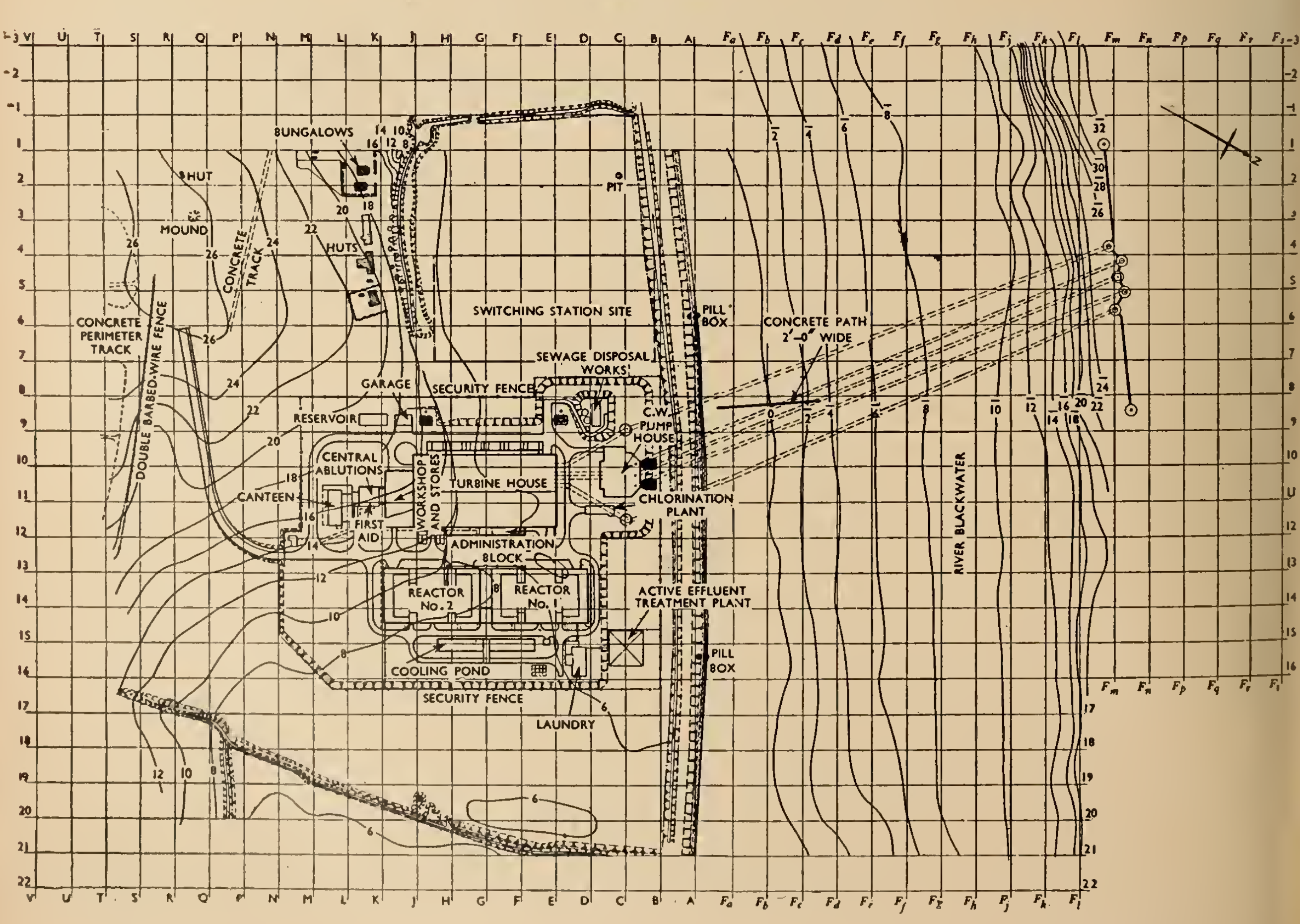


Fig. 6. Capital cost and net electrical output.

Fig. 7. Layout of nuclear power station (Bradwell).



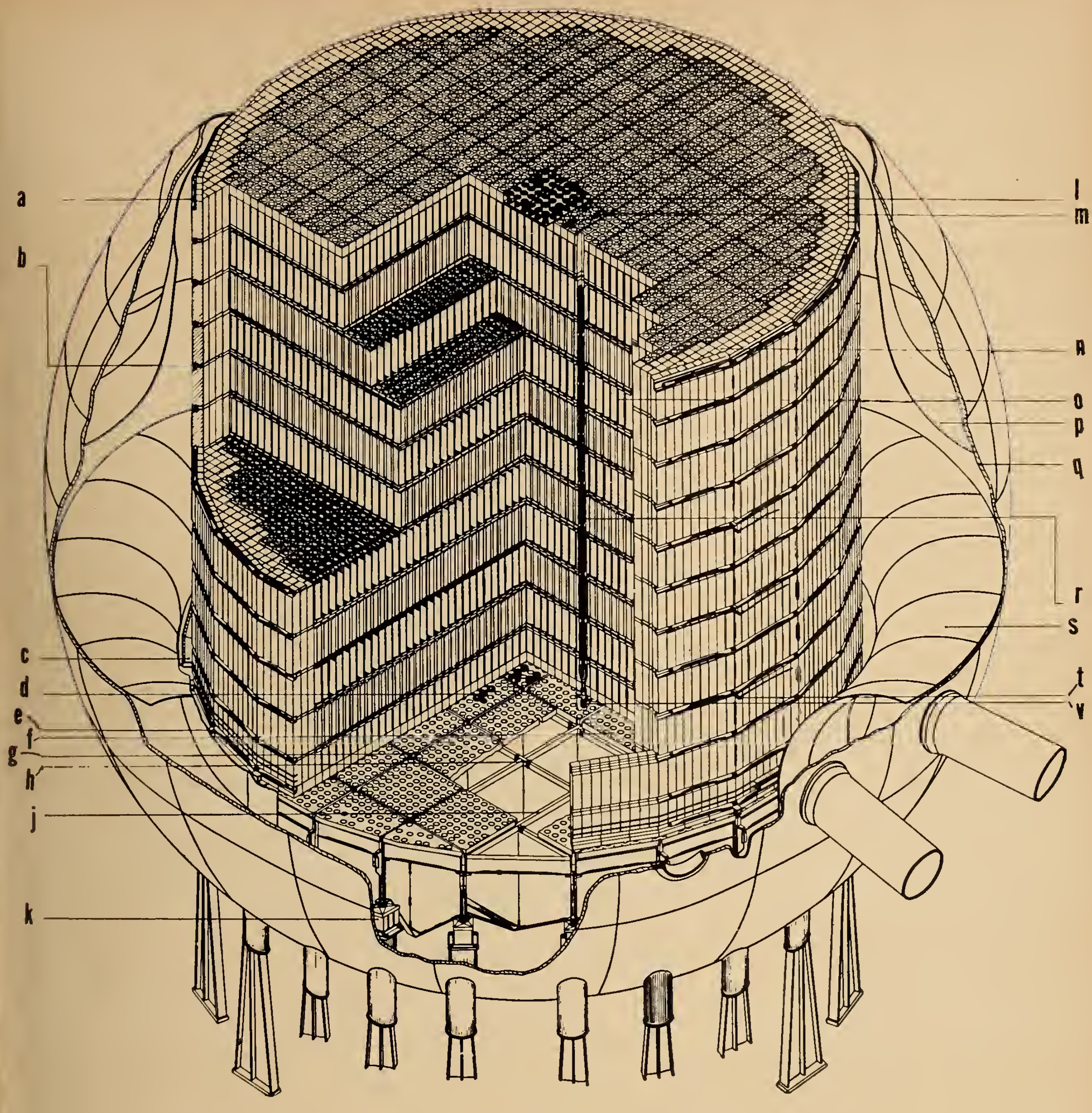


Fig. 8. Section through reactor core.

a Topside restraint. b Intermediate side restraint. c Gas seal. d Graphite support bearing. e Bottom side restraint and radial keys. f Support plates. g Levelling screws. h Levelling pads. j Diagrid. k Roller supports. l Charge pan. m Charge pan support. n Reflector bricks. o Moderator bricks. p Gas baffle. q Pressure shell. r Fuel element. s Toroidal shield. t Wigner growth measuring device. v. Fuel element support lantern.

power and those parts have become strongly radio-active. Charge and discharge mechanisms and control rods should all be capable of withdrawal and replacement if necessary. The full long-time effect of radiation is not as yet sufficiently known to face the possibility of failure inside the reactor of any moving parts which could not be removed.

STATION AT BRADWELL, ESSEX

The major particulars of the nuclear station at Bradwell, Essex, for the Central Electricity Authority are:

Guaranteed net output 300 Mw.

Reactor vessels. Two reactors each contained in a sphere of 66 feet in diameter in 3-inch thick special steel.

Heat exchangers. Six heat exchangers or boilers per reactor with dimensions substantially similar to those at Calder Hall but with double the unit heat output.

Gas pressure. Carbon dioxide circulated at 10 atmospheres pressure.

Steam conditions. Dual presssure cycle with steam at 730 lb. per sq. in. gauge, 700 deg. F. and 180 lb. per sq. in. gauge, 700 deg. F.

Cycle efficiency. Net cycle efficiency taking into account all station auxiliaries will exceed 28 per cent.

Turbines. Six main turbo-alternators which together supply power direct to the national grid, to the station auxiliaries, and to the variable-speed reactor gas circulators. The total installed capacity of all machines is 390 Mw., which includes a margin for subsequent improvements in reactor performance. One of the auxiliary turbo-generators serves as a standby for the other two. The main turbines have two cylinders with twin exhausts and are arranged across the station.

Fuel charging. Reactor designed for continuous recharging of fuel while remaining at full output.

Goliath or gantry crane. The compact arrangement of reactor buildings seen in Figs. 1 and 2 has made possible the employment of a new tool for rapid erection of the station. This is a Goliath crane of height 140 feet, span 167 feet, lifting capacity 200 long tons.

Fig. 7 shows a layout of the nuclear station which is on the estuary of the River Blackwater, in Essex. The soil is mainly typical 'London' clay and provides some difficult civil engineering problems.

Fig. 8 shows a section through the core of the reactors for the Bradwell station. The machining of the graphite blocks calls for a high degree of accuracy, to ensure the correct alignment of fuel-rod channels and to prevent neutron streaming at joints yet still allowing for some measure of Wigner growth. The geometry of core design demands great patience and critical analysis.

FUEL ELEMENTS

A number of severe thermodynamic and mechanical problems are involved in the design of the fuel elements. The use of natural uranium as the fuel limits the canning material at present to magnesium or possibly aluminium. Magnesium is superior on two accounts — lower neutron capture and better compatibility with uranium — and has therefore been selected for Calder Hall and for the British stations now building, in spite of the well-known limitations in the physical properties of this metal. With magnesium the maximum surface temperature of the fuel can is limited to approximately 450 deg. C. (842 deg. F.) and the aim in design is therefore to obtain the optimum between the conflicting demands of high outlet gas temperature, high heat rating in the fuel, and an economic pumping power.

The choice of a suitable heat-transfer surface is further complicated by nuclear considerations. The amount of metal in the can, the channel diameter and the disposition of the fuel are restricted within certain limits by the nuclear design. The 'optimization' of all these parameters is a formidable problem which is always present as new surfaces and canning materials are developed and as further experience is obtained on core design with respect to fuel-rod geometry.

The mechanical problems are concerned with the support of the elements in the channel, and the forces imposed on the fuel and canning material by the method of support. Consideration must also be given to the handling of the element during charge/discharge operations at power, and the strength of the element must be sufficient to resist damage under these conditions.

Natural uranium changes its crystalline structure at about 650 deg. C. (1,202 deg. F.). Though this in itself is not significant the considerable change in volume accompanying it can lead, especially if repeated several times, to the complete loss of the mechanical strength of the fuel bar, and, what is more important, to the destruction of the container surrounding it, thus allowing fission products to escape. Consequently, for the time being, the temperature at which this α-β transition occurs dictates the temperature limit of the reactor.

For nuclear reasons, the shape of the uranium should be such that the ratio of surface to volume is small but this is in direct contrast to the requirements for maximum heat removal. Practical reasons of support preclude the use of spherical fuel elements and, with one cylinder per channel, the fuel-rod optimization requires a diameter slightly over 1 inch. Uranium is such a bad heat conductor that with the reactor on load there is a temperature drop of about 100 deg. C. from centre to periphery of the fuel rod. A further, though smaller, temperature drop occurs at the boundary between uranium surface and can surrounding it. The temperature drop in can wall and fins is small but that between can surface and cooling gas is appreciable and so is that between cooling gas and working fluid. All those temperature drops, which constitute ther-

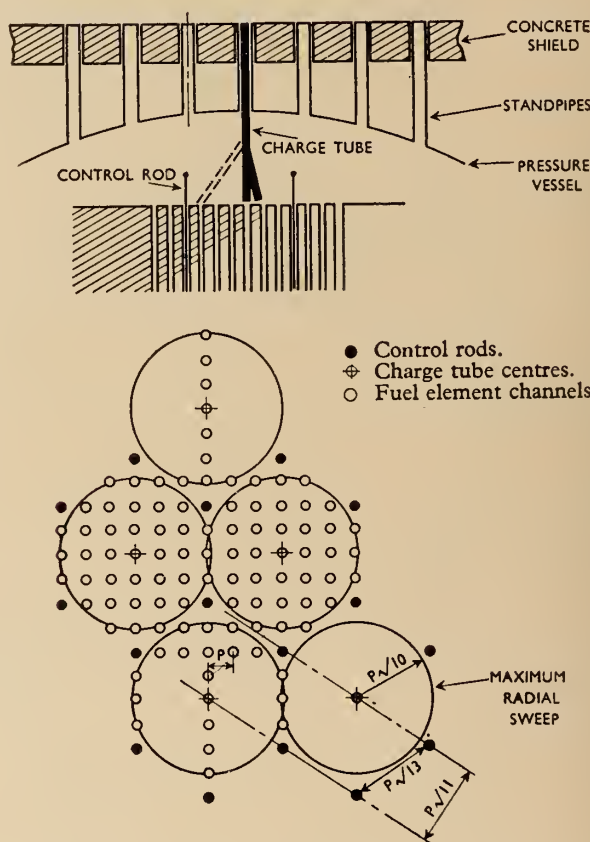


Fig. 9. Control rod and charging system.

modynamically irreversible losses, are a challenge to the applied physicist.

To reduce the temperature drop, we should work at high Reynolds numbers; apply large secondary areas, and create surface configurations which produce high heat transfer with relatively low pressure drops.

High Reynolds numbers necessitate, in order to keep pumping power within acceptable limits, high gas pressures or short channels. The gas pressure is limited by the pressure shell which is large and hot. Shortening of the channels leads to an increased diameter to height ratio of the core and thus reduced neutron economy, as well as uneconomic design of the pressure vessel.

Applying large secondary areas leads to increased neutron capture which, particularly with natural uranium, soon exceeds acceptable limits but also its thermodynamic effectiveness falls if the can fins become either too long or too close.

Hence it is to surface configuration that special attention must be given. The thermal conductivity in gases being low, the aim must be to scour the hot fuel element surface continuously by cooling gas, which is as nearly as possible at bulk gas temperature. This is best achieved if the gas which has been heated by contact with the fuel element is periodically transferred to, and replaced from, the main gas stream. It is important that this process be accomplished with the formation of few free vortices, which tend to increase the pressure drop without correspondingly increasing heat transfer. A considerable advance has been achieved by such a development.

The uranium in a power reactor will be at temperatures in the range 200 to about 600 deg. C. (392 to 1,112 deg. F.), depending upon the position of the element in the core. At the higher temperatures, the uranium is relatively weak and there is also evidence that creep may be accelerated by irradiation in the low-temperature portion of the reactor. Therefore the uranium must be arranged so that the forces imposed by its own weight are relatively small or, alternatively, supported continuously along its length to resist distortion.

Under irradiation, volume changes occur in the uranium, and the canning material must be sufficiently ductile to absorb these changes without splitting and thus exposing the uranium to the gas. The sealing of the ends of the can, the restraint applied by the extended surface and the metallurgical properties of the canning material are each important factors.

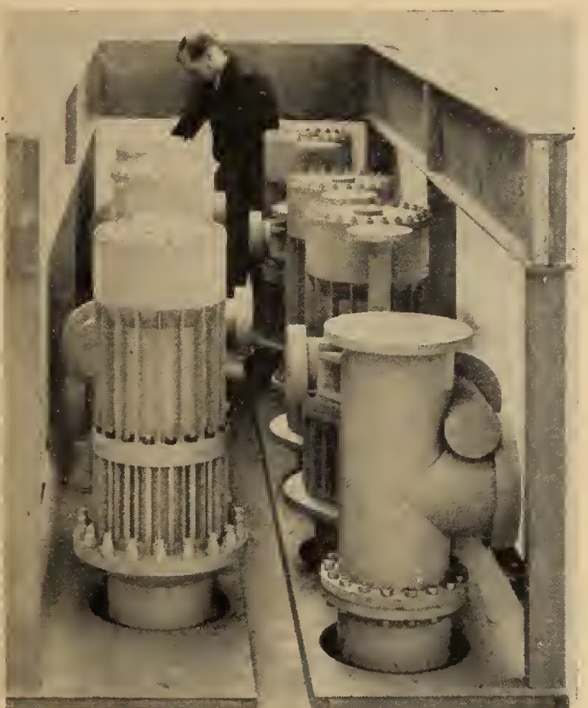
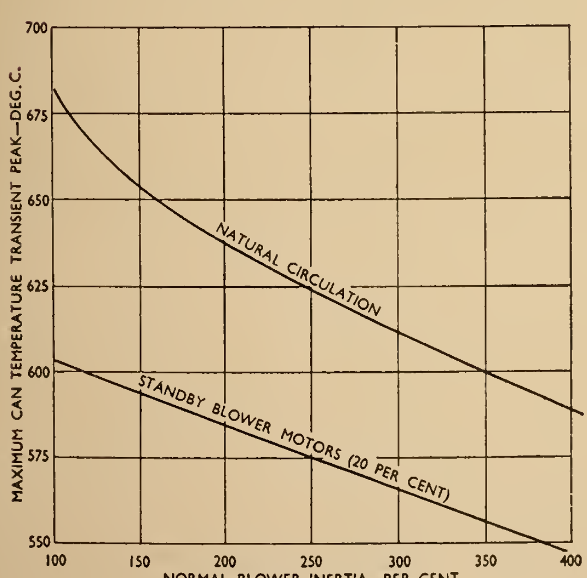


Fig. 10. Model of a portion of a pile cap.

Fig. 11. Blowers fail. Control rods fail to trip.



Refuelling

For several reasons, including the containment of maximum size of core in a given pressure vessel, load of duct work, better natural circulation in the event of circulator failure, stress and differential movements in the core and pressure vessel, a core with vertical channels is preferable for power reactors. Refuelling has therefore to be carried out completely either from above or below or by passing new fuel in at the top and spent fuel out of the bottom. The last method has many attractions but requires twice the equipment and cannot be justified economically. Systems for refuelling from below have been devised, but they involve the insertion of relatively complex mechanisms into the pressure vessel and operating rams into the core. Thus it is possible that their reliability may be less than the simple mechanisms which are gravity assisted when charging from above.

It is at least highly desirable that refuelling on load be carried out without interference to the control system. This implies the use of separate standpipes for refuelling and control rods. The necessity to achieve a minimum ratio between fuel channels and control rods in the core determines a minimum pitch of the control-rod standpipes. The problem is to be able to insert charging standpipes between the control standpipes without weakening the pressure vessel, while maintaining adequate strength and the shielding properties of the reactor-roof biological shield, and achieve satisfactory coverage of fuel channels below the charging standpipes and avoid interference between the control rods and charging mechanism which has to be inserted into the vessel. A typical arrangement which meets these requirements is shown in Fig. 9. Fig. 10 shows the full-size model which was prepared to test accessibility and the ability to locate the essential reinforcing steel in the biological concrete shield.

SAFETY

It is now generally accepted that the gas-cooled graphite-moderated reactor does not present any hazard to the general public. Equally important, although not generally appreciated, is the fact that by careful design, it can be arranged that the reactor will not suffer serious damage due to the failure of its control or main cooling systems. The prime consideration in this respect is the prevention of excessive fuel temperatures. If at any time the ratio of the heat output to coolant flow exceeds the design value, overheating of the fuel will occur. An increase in this ratio can be due either to an increase in heat output or a decrease in coolant flow. It is essential that under either condition the rise in fuel temperature shall be a minimum.

The most likely cause of increase in reactor power is withdrawal of the control rods. It is very simple to arrange the maximum rate of withdrawal so that maloperation at start-up cannot produce dangerous power surges and the possible rate of rise of power at operating levels made such that, should automatic tripping devices fail, there would be time to make manual correction on receipt of warning given by a number of independent devices.

Reduction of coolant flow due to a failure of the main circulators would cause a more rapid rise in fuel temperature than that due to control-rod withdrawal and particular attention must be paid to maintenance of an adequate flow of coolant at all times.

Elaborate systems of protection are provided to ensure immediate reactor shut-down following such incidents as failure of main circulators, excessive gas pressure, excessive fuel temperature, and excessive power level, but when considering the inherent safety of the reactor, the reliability of the protection systems cannot be assumed.

The most serious case to be considered is, therefore, coincident failure of the main circulators and the trip circuits. Under this condition the transient temperature rise of the fuel elements depends upon three main factors:

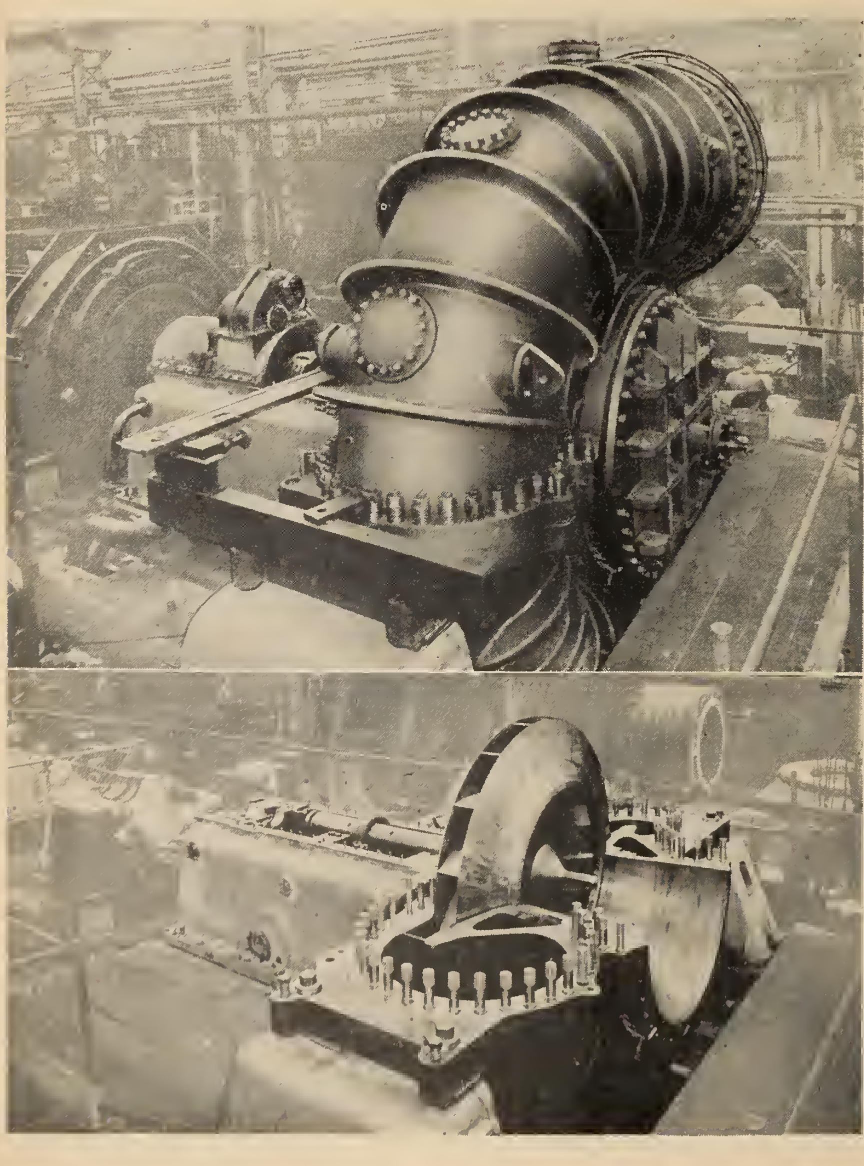
(1) the negative uranium temperature coefficient of reactivity;

(2) the run down time of the main circulators;

(3) the capacity of standby coolant plant and the natural circulation inherent in the coolant circuit design.

As soon as the flow of coolant falls, the fuel temperature rises, and because of the negative temperature coefficient of the fuel, the power

Fig. 12. Centrifugal gas blower.



starts to fall. If the rate of change of flow is small enough, the power falls almost in step with it and there is only a slight rise in fuel temperature. However, the collapse of power cannot follow rapid reductions in flow and the rise in temperature can be excessive.

The rate of fall of flow on failure of the main circulator drives can be reduced by increase in the inertia of the main circulators. The effect of this on maximum fuel temperature is shown in Fig. 11. By careful design of the coolant circuit, it is possible to achieve a sufficient flow of coolant by natural circulation to remove the heat and keep the fuel element temperature only slightly above the normal operating level when ultimately the circulators come to rest. The provision of auxiliary circulator drives which automatically take over and maintain forced circulation further limit both the maximum and final fuel temperatures. This is also shown in Fig. 11.

During the transient following circulator failure, the increase in coolant temperature causes increase in coolant pressure which, if great enough, would cause the safety valves to lift. With a suitable rundown time of the main circulators, this blow-off can be prevented.

The fracture of a main duct or other portion of the pressure circuit with consequent loss of coolant is a possibility which must be considered in the mechanical design of these components and, particularly with the expansion joints, long time life tests with pressure and temperature cycling are necessary researches to make preparatory to finalizing design. Should, however, failure occur, with auxiliary drives to the circulators maintaining them at 20 per cent normal speed, the fuel temperature can be maintained only slightly above the design value with the coolant at atmospheric pressure. With natural circulation, while the temperature rise is considerable, it is still appreciably below the melting point of the fuel cans.

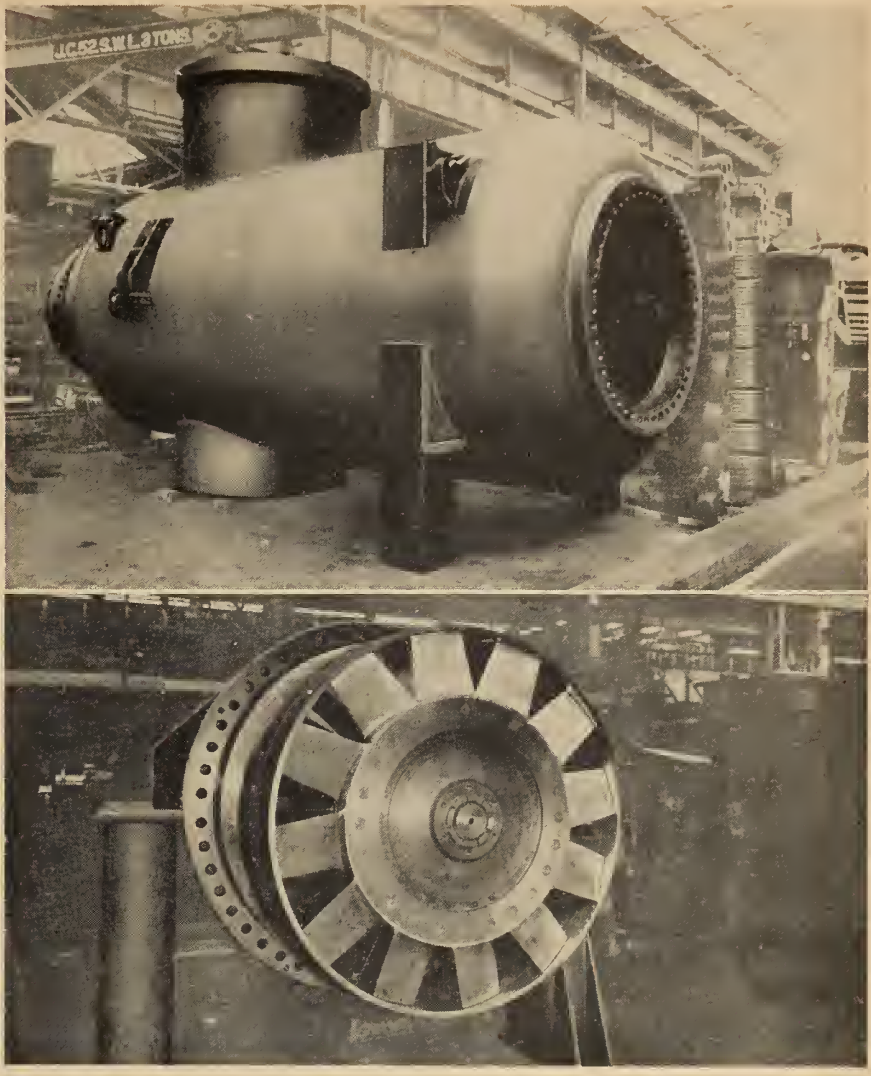


Fig. 13. Axial gas blower.

THE REACTOR VESSEL

In the construction on site of large vessels made from thick plates brittle-fracture is a definite hazard since the danger of this increases with the size of the vessel, the thickness of the plates and the depth of the welds which, besides increasing the stress due to welding, increases the difficulty of locating defects. Once the vessel has been constructed and stress relieved the danger of brittle fracture is diminished but not eliminated, since, although the plant operates at a temperature well above the transition temperature of all steels, it is subjected to a pressure test while cold before being charged, it is almost certain to be allowed to cool sometimes during its life and it is known that irradiation raises the transition temperature of the steel.

The danger of brittle fracture in pressure vessels can be reduced by using a low-carbon, high-manganese, aluminium-killed steel with a low transition temperature, that is, a high notched bar toughness at low temperature. But such steels have poor creep properties at high temperatures. Silicon-killed carbon steel has been used extensively in high-temperature plant and has good stress/-temperature properties but would be likely to fracture on site in cold weather.

One solution is to use a silicon-killed, high-manganese, low-carbon steel and thus obtain the high-temperature properties associated with boiler quality steel suitable for high-temperature service combined with a fairly low transition temperature. Another solution is to obtain, by the addition of alloying elements, a steel with satisfactory stress/temperature properties and a sufficiently low transition temperature. A steel that appears to fulfil those requirements has been developed and is under long-term high - temperature high - stress testing.

An obvious solution to this difficult problem is to build a double-shell vessel in which a thin inner shell that takes the temperature is made from a suitable steel while a thick outer shell that takes the pressure is kept cool and can therefore be made from an aluminium-killed steel. Like many first solutions in engineering problems, the difficulties increase as detail design develops. The double-skinned reactor vessel becomes less promising when endeavouring to accommodate gas ducts, control rods, and charge-discharge standpipes.

Were it possible to increase gas temperatures to the point that austenitic nickel-chromium steel became economic for the pressure vessel, the problem might be simplified, since this steel combines a high resistance to brittle fracture with good mechanical properties at high temperature.

Allowance in design must be made for the corrosion by hot carbon dioxide on the pressure vessels, ducts, circulators, and heat exchangers. Experiments have determined the wastage rates for the different steels used and adequate margins allowed.

The Cooling Gas

Helium and hydrogen are alternatives to carbon dioxide for the coolant. The use of helium would simplify the metallurgical problems but this gas is expensive and in short supply. The use of hydrogen would, however, intensify the metallurgical problems because uranium reacts with hydrogen to form a hydride of lower density, and hydrogen diffuses readily through many metals at high temperatures so that it would be difficult to find a canning material which, while suitable in other ways, would prevent hydrogen reaching the uranium and producing a volume expansion that would burst the can.

Blowers

The blowers to circulate the gas can be of the centrifugal or axial type. Mechanical problems, rather than aerodynamic problems, tend to predominate and the design of blower for a particular project will be influenced mainly by the form of station layout, the requirement for gas-tight enclosure and any limitations of speed imposed by the type of drive.

On the Calder Hall plant a centrifugal design was selected and the machine is shown in Fig. 12. In general the optimum speed for a centrifugal blower is much lower than that of the axial, and in this case the design was suitable for the Ward Leonard drive. The large diameter of the impeller, however, introduced a severe problem in obtaining a satisfactory pressure casing and a heavily ribbed structure is required to resist distortion at the sides. The horizontal joint also introduced gas sealing problems because of its size and shape. With regard to station layout, the centrifugal blower, unless mounted vertically, must impose a 90-deg. change of gas flow in the horizontal plane and this is not always desirable when considering duct expansions and general aesthetics.

If the blower drive is suitable for a rotational speed of, say, the order of 3,000 r.p.m., then the duty for a gas-cooled reactor can be met by a single-stage axial design. The diameter of the pressure casing can be reduced compared to the centrifugal design, and this enables the impeller to be inserted or withdrawn horizontally to provide a better form of joint in the vertical plane which avoids non-circular shapes. Such an axial blower is shown in Fig. 13. The casing lends itself to fabrication and is designed on normal pressure vessel principles using dished ends. Large flat surfaces are avoided and the resultant increased rigidity of the vessel ensures that flanged joints are not distorted by pressure to produce gas leaks.

To attain a high efficiency with a single stage of axial-flow blading it is necessary to provide an efficient diffuser at exit and to keep the axial velocity of the gas as low as possible. The blower shown in Fig. 13 is arranged with the diffuser coaxial with the shaft to obtain the highest possible efficiency.

The single impeller can be conveniently accommodated on an overhung shaft and only one gas seal is required. A seal suitable for the gas pressures and speeds of these special blowers has been developed from hydrogen-cooled alternator practice. The seal requires oil and the system must be designed to prevent contamination of the gas in the circuits. Present development work is aimed at a gas viscosity plate type of seal which will avoid the use of oil, but much work remains to be done in this direction.

A further possible line of development is the use of gas bearings to enable the complete enclosure of blower and motor in a gas-tight casing. Apart from the problems present in the design of suitable gas bearings, there are others such as the cooling of the motor and the possible contamination with active matter which would complicate maintenance. Although an enclosed design would have advantages from considerations of gas leakage and layout, it is a matter for conjecture whether these advantages would outweigh additional complications. If a suitable gas viscosity seal can be developed then this may prove to be an attractive solution to the problem.

Blower Drive

It is essential that the driving units of the blowers should be reliable and have a high availability in service. Outages for maintenance or faults mean the loss of a complete circuit and an appreciable reduction in output.

The main problem associated with the blower drive is the provision of a variable-speed range. During operation as a base load station the output must be varied between about 70 and 100 per cent full load, and for the highest efficiency the reactor gas outlet temperature should be maintained while the mass flow of gas is reduced by change of blower speed. Apart from retaining good steam conditions by this method, there is an appreciable saving of blower power. At 80 per cent load, for example, the blowing power is reduced to about one half of the normal requirement, and on a large station this may mean a saving of 10 or 15 Mw.

Speed variation between about 70 and 100 per cent of normal speed is therefore required on this account, and it is also desirable to have a small overspeed margin to cater for unknowns in the design which might otherwise prevent the guaranteed station output being obtained at design temperatures. In providing such a speed range, it is usually possible to specify a wider range of, say, 5/1 without materially increasing the cost of the equipment. The facility of being able to run the blowers at low speeds or at any desired intermediate value up to full load increases greatly the flexibility of operation, and can help to avoid undue thermal cycling of fuel element temperatures.

The speed variation may be provided in several ways, for example, by variable-frequency or variable-voltage supplies to electric motors, by hydraulic couplings or by direct steam-turbine drive. As stressed previously, reliability is the outstanding consideration and a squirrel-cage induction motor, used in conjunction with a variable-frequency supply or alternatively a hydraulic coupling, is to be preferred for the blower drive. The variable-frequency drive is superior in having good efficiencies down to quite low speeds, and the power savings at part loads can be shown to justify the extra capital cost of auxiliary turbo-alternators to provide the supply. These auxiliary turbo-alternators reduce the output required from the main machines and therefore ease the turbine exhaust problems on the larger machines.

Gas Ducts

Gas cooling of the reactor requires a number of ducts of large total flow area to transfer the heat output to the boilers even though gas pressures of about 10 atmospheres are used. The main problem in providing the flow area necessary to give an economic pumping power is to limit the duct diameter to a dimension which will allow the thermal expansion of the pressure vessel, boilers, and ducts themselves to be accommodated. The diameter should also be such that severe problems are not introduced into the design and manufacture of gas valves required for isolation and possibly control.

The choice of the number and diameter of the ducts is obviously a problem which is closely related to the problems of the boiler design, and a compromise must be found for both of these plant items, although the number of ducts per reactor and the number of boilers need not necessarily be equal. In general, however, the provision of a number of small ducts for each boiler circuit is not economically desirable and necessitates the control of a large number of valves. One duct per boiler is usually a better solution, and the use of restrained bellows units to accommodate the expansion avoids high thrusts on the pressure vessels and boilers.

If the ducting can be arranged so that it lies in one plane, then the bellows units are required to rotate in only that plane and a flexible torque rod mounted inside the unit can replace the external hinge pins normally used (Fig. 14). This type of unit avoids the problems associated with high bearing loads on the hinge pins and also the necessity for ensuring adequate lubrication to reduce friction.

STEAM CYCLES AND GENERATING PLANT

The gas temperature at outlet from the reactor is restricted to a maximum of about 750 deg. F. with magnesium fuel cans, and steam conditions are therefore representative of practice fifteen to twenty years ago. Overall cycle efficiencies with a normal condensing steam cycle would be about 26 per cent, allowing for a reasonable temperature difference between gas and steam in the boilers, but this efficiency has been raised to over 28 per cent by the application of the dual pressure cycle. Consideration has been given to other applications in order to improve upon this efficiency and these include triple pressure cycles, single pressure with reheat, and single pressure with separate superheating from external sources. In general, the dual pressure cycle offers a reasonable compromise between gain in efficiency and complexity and cost, and also offers the advantage that it can facilitate the control of reactor gas temperatures.

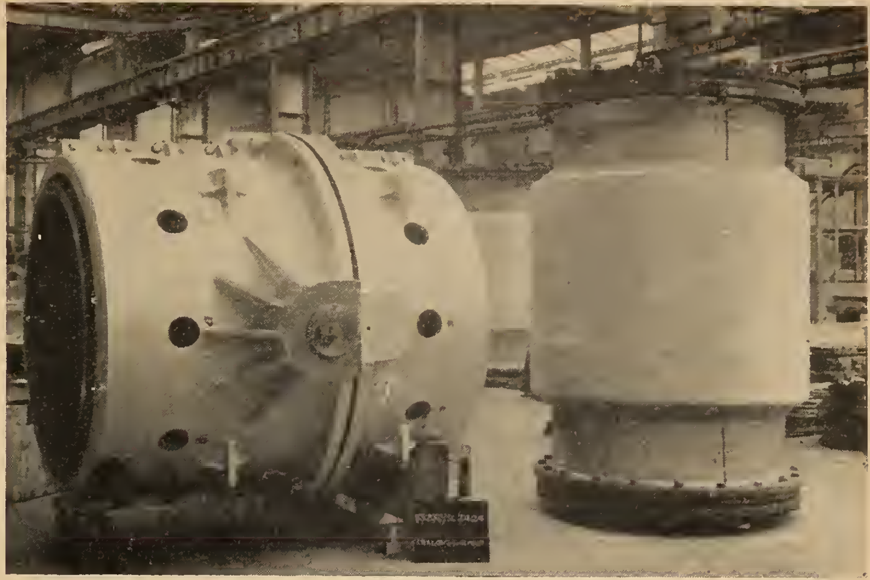


Fig. 14. Single hinged type of bellows unit.

In this cycle a quantity of steam is generated at a low pressure, say about 200 lb. per sq. in., and the remainder at a much higher pressure, say, 700 lb. per sq. in. This results in a turbine with two sections with two injection points, the first section being injected with steam from the high-pressure range expanding down to a mixing chamber. At this point steam is injected from the low-pressure range and mixes with the steam from the high-pressure section and finally expands through the second section to a condenser. The choice of high-pressure and low-pressure operating pressures for optimum efficiency is dependent upon the degree of feed heating and the ratio of high-pressure steam quantity to low-pressure steam quantity. The steam pressures at the optimum efficiency produce a high wetness at the turbine exhaust, and because of low temperature there is a large volume flow of steam for a given output in comparison to modern machines. The design of the exhaust is therefore the limitation on unit output, and with two exhausts an output of 50-60 Mw. is achieved at a speed of 3,000 r.p.m. compared to 120 Mw. for a plant operating at 1,500 lb. per sq. in. and 1,050 deg. F. The steam wetness and volume flow show little reduction in moving from the optimum efficiency and there is no incentive to lose station output for only a small improvement in these parameters. Consideration has to be given to the use of Stellited blades, water extraction belts and a reduction of blade peripheral velocities in order to obtain a satisfactory design of turbine. The use of three or four exhausts will be necessary to attain unit outputs of 100 Mw.—moderate by present-day standards.

To obtain maximum cycle efficiency it is desirable to raise both the high-pressure and low-pressure steam to the same temperature in the superheater section of the boiler. Large temperature differences are created between the low-pressure steam and the steam in the turbine at the low-pressure injection point, and care has to be taken to avoid problems of differential expansion.

The introduction of two injection points into the turbine presents a problem of control. Also associated with this is the problem of control of the reactor-gas inlet temperature. In a nuclear reactor it is advisable to keep thermal stresses in the fuel elements to a minimum and it is to this end that the temperature of the gas at inlet and outlet are kept substantially constant. The inlet gas temperature is controlled by the low-pressure steam pressure in the boiler and, to achieve this, a pressure-control valve is installed in the low-pressure governing system. The high-pressure steam pressure has little effect on the inlet gas temperature and therefore does not require pressure control for normal operation. However, it is not advisable for the high-pressure to be allowed to float up or down unchecked as load demands fluctuate, and a definite limit has to be set on this range. Control of the lower limit is achieved by the introduction of a high-pressure unloading device set at a predetermined level which unloads the turbine should the pressure in the line fall below the control setting. The higher limit is controlled by the use of a valve which operates if the pressure in the line increases to above a predetermined setting, allowing the steam to flow into a dump condenser.

Speed governing of the turbine is also essential if the turbine is to have normal frequency regulation. This has to be incorporated in the governing system and it is essential that it does not interfere with the reactor-gas inlet temperature control. This necessitates the introduction of two separate governing systems, one for the high-pressure steam which is used for speed control and the other for low-pressure steam which is used for pressure control.

LIFTING FACILITIES

The method of construction of a nuclear power station can strongly influence the overall design and must be considered in the initial planning.

There are two fundamental methods of constructing the large pressure vessel and boilers on the site, and the method adopted is largely dictated by the time available for construction.

If a speedy erection programme is required, and this is generally the case on a large capital contract, then, undoubtedly the best method of construction is to fabricate the large sections of the pressure vessel and complete boiler shells in construction areas away from the reactor buildings. This method of construction gives the minimum of mutual interference and allows the various trades to perform very exacting operations in less confined spaces. In the case of the pressure vessel, this method allows the further use of automatic welding and, in particular, eases the very real difficulties which are encountered in the fabrication of the vessel cap and the charge and standpipe assembly tubes. The boiler shells can also be automatically welded and hydraulically pressure tested in a horizontal position.

The other method is to weld the plates of the pressure vessel and boilers *in situ*. It can be shown, however, that on a large nuclear power station, the construction time will be lengthened.

An economic study of the two methods shows that quite apart from the workmanship aspect of the construction, the saving in time of the former, far outweighs the cost of a crane capable of lifting some 200 tons.

Advantages of Crane

Of the four practical ways of lifting the pressure vessel parts and boiler shells into position, a Goliath crane has many advantages. It is estimated that a saving of at least four months can be achieved, due to the high availability of the crane and complete freedom within the erection programme, when compared with its nearest competitor. Furthermore, the Goliath tracks can be extended away from the reactor to cover a marshalling yard which reduces the congestion around the reactor buildings during the civil engineering construction, and, as the Goliath would be designed to span the completed reactor building, a single construction area can serve more than one reactor.

Mention should be made of the nearest competitor to the travelling Goliath, which is the tower-mounted guyed derrick. Undoubtedly its initial cost is lower than the Goliath but it has the following disadvantages on a large nuclear power station. Due to the limited operating radius of the jib, it is necessary to frequently relocate the tower and the very long guy ropes. A large and specialized labour force is necessary during most of the construction period to carry out the lifting and frequent relocation of the derrick and tower. The necessary guys can also affect the layout of the principal buildings and generally prevent the engineer from siting the main buildings close together, and in their ideal engineering position.

These disadvantages, together with a longer construction time, when compared with the travelling Goliath would indicate that the extra capital cost of the Goliath is well justified.

Other types of crane tend to eliminate themselves on capital cost and appear to possess no additional operational advantages.

SUMMARY

From every point of view, economic, metallurgical, and mechanical, it is essential that the pressure vessels, reactors, ducts, boilers, and circulators should be maintained at as near constant pressure and temperature as possible. In that way, safety and reliability are maintained at the highest level and this in turn leads to the lowest cost per unit of electricity sent out. The whole philosophy of design must be directed to this end. It is a well-established fact that the extent of maintenance on turbo-generators bears a direct relationship to the number of times the units are started and stopped. It is stress and temperature cycling which leads to increased maintenance costs.

The reactor vessels particularly should avoid stress cycling since the irradiation effects on the crown of the shell are thus made of little consequence and no danger.

The boilers will receive oxygen-free condensate feed if the turbo-generators are continuously on load and on the gas side will have relatively pure carbon dioxide. Hence the amount of maintenance required by the boilers should be negligible.

CONCLUSION

It has been possible to mention a few only of the many problems associated with the development of industrial nuclear power and those only briefly. It is hoped that they will have been of interest and have shown how closely interrelated are the many components of a nuclear power station.

ACKNOWLEDGMENT

Many colleagues in the team of designers with whom I am proud to work have contributed to these notes, and my acknowledgment and thanks are gladly given to them.

Will Ultimate Strength Design of Reinforced Concrete Beams Simplify Stress Calculations?

E. M. Rensaa, M.E.I.C.

Rensaa & Minsos, Edmonton

THE FUNDAMENTAL principles of design of reinforced concrete structural members have lately come in for an increased review and criticism. It is especially the correctness of stress calculation and safety factors which are being questioned. This applies particularly to the concrete part of the combination section for which actual stresses may differ considerably from those calculated by the triangular stress distribution theory. At present, structural members are designed on the basis of assumed dead and live load conditions and on allowable stresses for concrete and reinforcing. Some engineers think that ultimate stresses and load carrying capacity of the member should rather form the basis for design. Allowable loading would then be reduced to a certain proportion of the maximum capacity of the member. In this article an attempt will be made to discuss some of the considerations that have a bearing on which of the two methods should be preferred. This discussion will be limited to horizontal members in bending.

One of the first to use reinforcing in a concrete beam was an Englishman, W. B. Wilkinson, who in 1854 patented such a combination. This was followed by other inventors of which the best known is the Frenchman, Monier. The first designs were based on trials and guesses as no method of calculating stresses in such reinforced members was known. It was as late as 1886 that the German engineer, Koenen, developed a fairly accurate method of calculating the stresses in reinforced concrete beams. The design theory of reinforced concrete is thus only 70 years old which is rather surprising when considering the tremendous amount of such construction that has been done. A great deal of testing and theoretical investigation was carried out during the two decades following the development of stress analysis and it may be said that the principal facts of reinforced concrete had been learned shortly after the turn of the century.

There is currently much discussion about the advisability of abandoning the use of working stresses and adopting ultimate strength as the basis for design of reinforced concrete members. Opinion on this is divided, and the author here presents a valuable discussion on the controversial subject.

Assumed Stress Distribution

Our present method of calculating stresses in a reinforced concrete member is based on Hooke's law that strain is proportional to stress and on Bernaulli's hypothesis that a plane section remains plane after bending. It was known quite early from tests that none of these assumptions are strictly correct for high concrete stresses. An originally plane section is certainly not plane after it is partly cracked. The value of the modulus of elasticity would not only depend on the concrete strength but would also vary with the stress. This will often make concrete stresses, calculated by use of the triangular stress distribution theory, quite erroneous for ultimate load conditions and especially if concrete forms the weaker part of the section. The calculated stresses will be much higher than those obtained from direct compression tests of the same kind of concrete. The early investigators understood quite well that the reason for this apparently higher beam strength was not that concrete in a beam became so much stronger but that the stress distribution was more favourable than indicated by the straight line theory. Both European and American engineers, early in this century, proposed other kinds of stress distribution than the triangular type for calculation of ultimate concrete stresses. The reasons for adopting the straight line triangular stress diagram was not ignorance of true conditions as some now might believe but rather that it did not seem possible to find a simple method which would be universally applicable for all steel percentages, concrete strengths and load conditions. The problem of developing such a satisfactory simple method is, in the author's opinion, still unsolved.

It was found early that the triangular stress distribution would be accurate enough for the purpose of obtaining the strength of a beam where the steel strength was the deciding factor. For a beam with such a high steel percentage that the concrete would fail first, it was quite obvious that concrete stresses calculated from triangular stress distribution was rather fictitious. However, by raising the allowable concrete stress to such an extent that the concrete section in bending only retained a proper safety factor, no economy was really lost. It is, therefore, incorrect to contend that the stresses allowed at present are not based on ultimate concrete strengths. When for concrete beams we allow a working stress of 45 per cent of the axial crushing strength at 28 days and only about half of this stress for axially loaded columns, it is not because we think that actual safety factors for beams could safely be that much lower. The allowable stresses are therefore based on tests of ultimate strength and not on a theory which only has a limited field of approximate correctness. Outside such a limit, we must find another theory which will conform to applicable test results. Theory is necessary as a means of enabling us to design members which in form and function are not materially different from those which have been tested and investigated previously. Any theory, which is to be usable must, however, be in accordance with the laws of nature.

Condition Governing Ultimate Strength

There are two principal conditions which govern the ultimate carrying capacity of a reinforced concrete member in bending. The first is the ability of the concrete section to resist compression and the second condition is the tensile strength of the reinforcing steel. It might appear that the best and most economical method would be to utilize both materials to their full capacity and then apply a certain safety factor applicable to both in order to obtain the allowable loading. Such a procedure may seem proper to theorists but generally it is not very feasible in practice. Members designed that way would not necessarily be the most economical even in the case of slabs and rectangular beams. In the case of T-beams, such a "balanced" combination is seldom economical. Furthermore, a balanced design might give very slender members which, when deflecting, could cause unsightly cracks in partition walls they might support. Simplicity of forming, desirable uniformity and architectural requirements, must also be considered. For all these reasons, full utilization of balanced design is rather the exception than the rule. Even if it was possible to build a structure in which for each member the critical section was of a balanced design, (the same safety factor for concrete as for reinforcing) it certainly would be impracticable to balance stresses along each individual member. In most cases when we want to obtain economy in a reinforced concrete beam, we maintain a uniform concrete section and decrease the amount of steel reinforcing to what is required by static conditions. We might thus get a condition where a certain part of member is over-reinforced, changing into parts having balanced reinforcing and then into under-reinforcing. To each of these conditions there would be a different concrete stress diagram and a different position of the neutral axis. Proper design of reinforced concrete members is, for the above reasons, just as much a matter of practical experience as of knowledge of theory. What is indispensable in any case, however, is a thorough understanding of the functions and limitations of reinforced concrete. In that respect, the ordinary American textbooks on reinforced concrete fall far short of giving sufficient fundamental information.

The modulus of elasticity of concrete is a very variable figure. It not only varies with the strength of concrete but also with the stress. Since the strength generally increases with age it also varies with this.

Critical Strain and Ultimate Load Capacity

Even more variable than the modulus of elasticity is the strain at which a concrete specimen carries its maximum load. This strain, which is not necessarily the maximum one, may vary considerably even for the same concrete strength. This critical strain varies also with the speed of loading which makes comparisons of results found by different investigators difficult. For axial compression test this strain is most often somewhere between 0.15 to 0.25 per cent of the length, but greater variations from 0.1 to 0.3 per cent are sometimes found. After the maximum load has been reached breakage will follow so quickly that it is difficult to measure the strains corresponding to decreased stresses. Even so, some investigators claim to have established such stress-strain relations considerably beyond the point of maximum load. It may be questionable how much reliance can be placed on the internal coherence of concrete which has passed the maximum stress stage. It is most likely that diminishing load capacity is caused by internal splitting and disintegration of the concrete test specimen and measurements beyond the maximum load capacity stage are thus probably worthless.

It is hardly possible to measure concrete stresses in a beam directly with sufficient accuracy. Several attempts have been made to carry out direct measurement of stresses in beams. (1) How reliable such measurements are may be questionable. Strains may however be measured without too much difficulty. It is, therefore, necessary to calculate the stresses from the measured strains on basis of what has been oberved for similar concrete under direct load. For beams it will be found that the maximum strain may be much higher, 0.3 to 0.7 per cent, than obtained for maximum load in direct compression specimens. If we assume that such high strain could only happen with a falling stress and that the maximum stress would occur for the same strain as in direct test specimens, we would obtain a concrete stress diagram somewhat as shown on Fig. 1. We do not know for sure, however, that with lateral support from less strained neighbouring concrete, the strain for maximum loads may not be higher in beams than in a test specimen where every part has about equal stress. One condition which points in that direction is the fact that an over-reinforced beam loaded by a concentrated load at the centre of span will sustain a greater bending moment than a similar beam with two loads placed at the third points exerting the same calculated bending moment. An extra bending moment capacity of up to 16 per cent has been found by tests. (2) While some of this extra load capacity may be explained by distribution of the single concentrated load to both sides down to the centre of beam, and by the possibility that the transverse pressure from the load might increase the compressive strength of

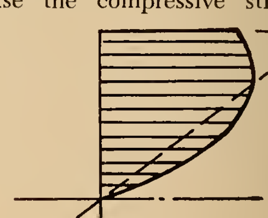


Fig. 1.

the most highly stressed concrete, this would hardly account for all of the extra strength. The fact that a sharply diminishing stress concentration may allow a higher unit stress was a good reason for permitting higher compressive stresses for negative bending moments at beam supports such as is contained in some building codes. It is clear, however, that since we cannot measure the stress variation in the compression zone directly with much accuracy, the actual distribution is to a considerable extent a matter of opinion. A great many assumptions have been and are being made in that respect varying from the second degree parabola to parabolas of 5th degrees or higher or even to rectangular stress distribution. (3) The probable truth is that there is no specific form for ultimate stress distribution in the compression part of a reinforced concrete beam. Both older and newer tests (4) have shown that the relation between concrete strength in beams and axially loaded prisms is not constant but varies to some extent with the concrete strength. The ratio may vary between 1.2 to more than 2 and generally decreases for higher concrete strengths. This would indicate that for high concrete strength we certainly may be far off if we assume the stress distribution to resemble a rectangle.

The question may then be asked if reinforced concrete, which shows such an uncertain and variable stress distribution, is not a rather unsafe material. That would also be the case if we tried to utilize what we think is the concrete strength right up to the limit. In practice, we generally limit the amount of reinforcing to such an extent that the strength of the beam depends on the tensile strength of the steel. Since steel is the most uniform and reliable construction material we have, this procedure makes the reinforced concrete beam about as reliable in bending as a steel beam. All we have to do is to use a higher safety factor for concrete to take care of its greater variability. Some concrete experts think that it is now possible to mix concrete which has such uniform strength that we could use almost as low a safety factor as for steel. Apart from the fact previously stated that full utilization of balanced design is most often impracticable, we must also consider the cost and availability of full scientific control. The majority of our jobs are so small that the cost of complete scientific control would, in most cases, be prohibitive.

In addition to the apparent impossibility of making strength of concrete as uniform as the strength of steel, we also have to contend with the effects of shrinkage, plastic flow and long time duration of load on strength and deflection. It is known that a concrete column under constant load will only carry 70 per cent to 80 per cent of its short time load capacity. Little is known about the carrying capacity of concrete in a beam under long time loading, but we may assume that about a similar decrease as for columns will occur. This reduction will eliminate from practical use the complete stress range beyond the maximum load and 20 per cent to 30 per cent before this load has been reached. The fact that loading above 70 per cent to 80 per cent of maximum capacity will eventually cause a failure would seem to prove definitely that this upper so-called plastic condition in reality constitutes a gradual internal disintegration of the concrete. We cannot, therefore, generally base the assumption of ultimate strength and safety factors on short time tests. So let us not be too optimistic about what savings we may make by adopting the plastic theory of stress distribution.

How Concrete Stresses Vary

Let us now consider how the concrete stress may vary along a beam uniformly loaded up to full capacity. The beam is under-reinforced so that its strength is determined by the tensile strength of the steel. Stress diagrams are indicated at four points along the beam. At section A, near the support we have a rather peculiar stress situation corresponding to that of a beam very high compared to its length. The neutral axis is quite low and the compression part of the stress diagram is not triangular. There is generally no tension crack this near the support and the concrete below the neutral axis will therefore carry some tension. (Fig. 2)

At section B farther out on the beam, we may still not have any tension crack. The stress diagram on the compression side is nearly triangular and the neutral axis has moved upwards possibly above the centre line of the beam. If the concrete on the tension side is stressed nearly up to the tensile limit, there may be some plastic deformation and the tensile stress diagram may be somewhat curved.

Section C shows the stress diagram for working loads after a crack has formed on the tension side. The neutral axis has moved farther upwards and there is only a negligible part left of the tensile part of the stress diagram. The compressive stress diagram is still not far from a triangular shape. The diagram may become more curved due to plastic deformation if the loading is heavy and of long duration.

Section D shows what happens after the steel has been stressed beyond its yield point. A large crack will form and the neutral axis and resultant concrete compression will move upwards giving the beam some extra bearing power. If the load is further increased the reinforcing will stretch even more, the compression zone diminishes until failure occurs by crushing of the concrete. Under-reinforced concrete beams will have an extra carrying capacity of 5% or more above the load which stresses the steel to its yield point before the beam fails by crushing of the concrete. The failure of such an under-reinforced beam is, therefore, relatively slow and there is a warning period during which the danger of impending failure may be observed and remedial measures taken.

It is clear that for an under-reinforced beam, it would make no dif-

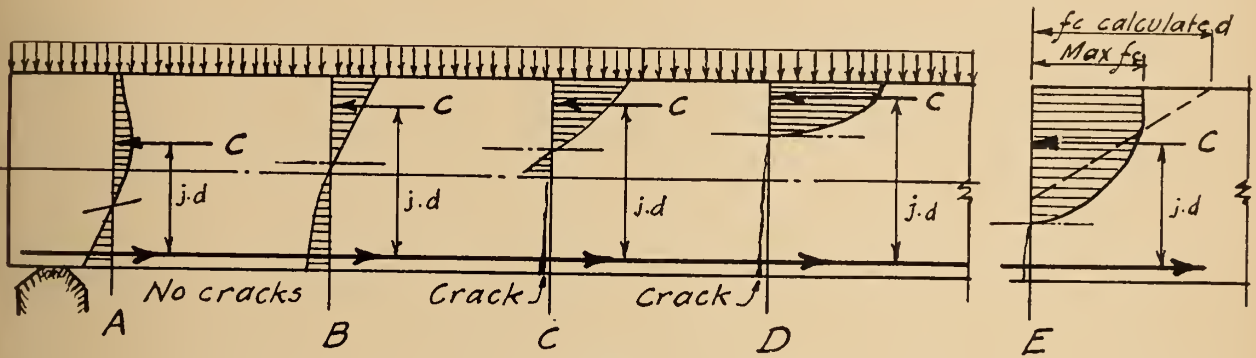


Fig. 2.

ference what shape we assume for the final concrete stress diagram near failure, since we know quite accurately the magnitude of the internal lever arm of the stress couple at the time the steel reaches the elastic limit. The strength of the beam depends principally on this limit and it would hardly be sensible to allow for the relatively small increase in carrying capacity after the steel has been stressed beyond that point.

Section E indicates how the concrete stress diagram might have looked for an over-reinforced beam near failure. There is considerable difference of opinion about the exact shape of this diagram. Most likely the shape is quite variable depending on concrete strength, etc. Since the ratio of beam strength to cylinder strength decreases as the concrete strength increases, the diagram will be less curved for high strength concrete. Duration of loading will also undoubtedly have a great effect on the curvature.

While for an under-reinforced concrete beam, the resultant compression will move upwards towards ultimate loading, the opposite is the case with over-reinforced beams. For such we get a decrease in the lever arm of the internal stress couple and a lowering of the neutral axis. Such a beam if overloaded will fail suddenly without any previous warning. Since the compressive strength of concrete is much more variable than the tensile strength of steel, a beam whose strength depends on the concrete will have a much greater variation of actual load carrying capacity than an under-reinforced beam. When some concrete experts advocate the plastic theory because our present method of design is wasteful, how far into this field of uncertainty do they want us to move? If it is found that we can safely increase the allowable concrete stresses, we might do so, but that does not necessitate the use of new method of design. It would, of course, be possible to save concrete if we allowed only a safety factor corresponding to 0.45 f'_c for the curved stress figure. That would be the same in reality as the raising of allowable concrete stress on the basis of a triangular stress distribution or, in other words, a lowering of the safety factor for the beam. If the same safety factor as at present were to be used, we would have to lower the allowable concrete stresses in compression to a figure closer to what is used for direct stresses. It should be understood that we cannot change the actual stresses in a beam by a different method of calculation. For a given beam design it makes no difference as far as strength is concerned how we arrived at the section either by calculations or by guesses. From a practical point of view our aim should be, with the least effort, to work out a safe, economical and practical design. The calculation of stresses for their own sake is quite unimportant. In practice such work need only be done to an extent where we can be sure of not having any "weak link in the chain".

It has been stated by proponents of basing reinforced concrete design on the plastic theory that by this means it will in most cases be possible to avoid the use of compression reinforcement. Such statements are again based on the wrong conception that we can modify actual stresses by a convenient method of calculation. It is uneconomical in most cases to use compression reinforcing in beams. The use of such reinforcing is only justified under conditions where it is required for short lengths, such as at supports, or where span lengths make saving of dead weight important, or where uniformity or limited height are important factors. We know that the distribution of stresses between concrete and compression steel is about the same as in a column. For that reason building codes allow us to assume the steel to be twice as effective as indicated by the usual calculation with triangular stress distribution and the specified "n"-ratio. We would not have gone very wrong in that respect if for ordinary beams we would allow the same stress for the compression reinforcing as for the tension reinforcing.

It seems to be impracticable to base our design of reinforced concrete beams on the actual stress distribution in the concrete since the distribution is so uncertain and variable. That more or less compels us to use a stress distribution which in some cases is fictitious. We would not gain much if we changed over to another assumed stress distribution which might be just as fictitious for other cases unless such a change made the end results more safe, economical and consistent.

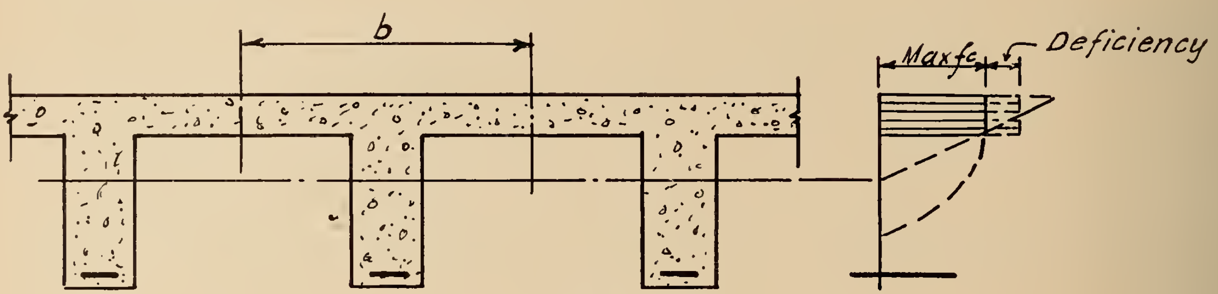


Fig. 3.

Over-reinforced T-Beams

Regarding safety and consistency, it must be admitted that the triangular stress distribution in conjunction with the allowable concrete stresses for working loads in beams does not always give satisfactory results. One such case deserves special attention and that is the over-reinforced or "balanced reinforced" T-beam. It happens occasionally that the stems of such beams are spaced so closely together that the complete flange width is utilized in compression. If the calculated concrete stress in such a beam is as high as that for a rectangular beam, we may then have a condition where the safety factor is much lower than for the rectangular beam. Looking at Fig. 3 the reason for this is rather obvious. In the over-reinforced rectangular beam, the concrete below the calculated position of the neutral axis comes to the rescue when a plastic deformation towards ultimate load conditions occurs. Below the thin slab flange there is no such concrete which will help to carry compression excepting in the relatively narrow beam stem. Our fictitious triangular stress distribution, therefore, does not give us

(Continued on page 840)

Electrical Energy from the Wind

E. W. Golding

Electrical Research Association, England.

The history of the use of wind power is traced briefly to provide a background to the present renewal of interest in the subject. The characteristics of the wind as a source of power are discussed together with its possibilities for the generation of electrical energy. A short review of the different types of windmill is given leading to a description of the main features of some recent designs. Wind-power research and development work in Great Britain is described with an account of the progress made during the last six years. The economy of wind power on three scales of utilization is dealt with and suggestions are made for making the most effective use of energy available. The author of the paper has played an important part in this work in Britain, and in other countries on behalf of their governments and of the United Nations; his book "The Generation of Electricity by Wind Power" treats the subject fully and authoritatively.

As CIVILIZED man, under the continual urge to improve his standard of living, realized the limitations imposed upon him by the paucity of his power resources as represented by human and animal power, he turned to the natural sources of energy, in the forms of falling water and the wind.

Water mills were apparently developed first and are referred to in Greek and Roman literature. In spite of casual references to very early windmills in Persia, the Middle East and China, no authentic accounts of their use much before the beginning of the Christian era can be found although in "The Pneumatics of Hero of Alexandria" a simple form of the horizontal-axis type of windmill is described. This would place its date about 200 B.C. Ancient remains of Persian mills — of the vertical-axis type and dating from about the 5th century A.D.—have been found, but the sail type of windmill, with a horizontal axis, seems to have appeared in western Europe only in the 12th century and the earliest reference to an English windmill is for 1191.

After that date they became increasingly common and, through the efforts of inventors such as Andrew Meikle, Edmund Lee, Stephen Hooper, Sir William Cubitt and John Smeaton — who presented to the Royal Society in 1759 a paper "On the construction and effects of windmill sails" — they reached a high state of development.

At one time some 10,000 windmills were running in Great Britain. They were widely scattered over the country but were commonest in the eastern counties, where they were used for corn grinding and water pumping. Their rotor diameter was often 60-80 ft. and their power output was 30-40 h.p. in a good wind.

While water-mills had to be located close to the water driving them, windmills were built, with a little more freedom in the choice of site, near to their work — hence their frequency of occurrence in the eastern counties of England, which are, in fact, much less windy than the western district.

With the introduction of the steam engine the windmills met competition which had previously been lacking, and their gradual decline in the 19th century was hastened towards its close by the re-organization of the flour-milling industry on the basis of large milling plants, dealing with vast quantities of imported grain. The fickleness of the wind was always a disadvantage and the specialized workmanship needed to maintain the old-fashioned windmills became less easy to find as the mechanization of industry advanced with the steam engine and, later, with electrification.

As the benefits of electricity became more widely recognized there was a demand for it in remote parts of this and other countries which had then little prospect of receiving a mains supply. Especially in windy districts such as those near our western coasts, on the Canadian prairies

LIST OF PRINCIPAL SYMBOLS

V_{am}=Annual mean wind speed.
V_p=Wind speed for full power capacity, or "rated wind speed."
V_c=Wind speed for "cut-in."
V_f=Wind speed at which an aerogenerator is "furled."
P_c=Rated power capacity.
T_s=Specific output in kilowatt-hours per annum per kilowatt.
C_p=Power coefficient, or (power produced by the rotor)/(power in the wind)
C_{op}=Overall power coefficient, or (electrical power output)/(power in the wind)
μ_0=Tip-speed ratio, or (peripheral speed of the blade tips)/(speed of the wind)

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and in the United States, the demand for electric light was met, in part, by the installation of many thousands of small wind-driven d.c. generators of up to some 3kw. capacity, operating with a battery for storage to cater for calm spells.

There, in general, the matter rested, but there were some instances of more ambitious developments. In Denmark, following the work of Prof. P. La Cour at the Danish State Testing Station at Askov between the years 1891 and 1908, wind-driven generators of up to 30kw. capacity were built. They were applied to various farm purposes and were used as supplementary generating units at the village power stations. These machines, with sail-type rotors, proved useful especially during the two World Wars when oil fuel was difficult to obtain. During the Second World War 88 wind-driven generating plants, some of which were of a new propeller-driven type of up to 70 kw. capacity, generated more than 18,000Mwh. for local supply networks in 7½ years.[1]

In Germany also, during the Hitler era, very large designs, some of which are best designated as "fanciful," were put forward. Their sizes ranged up to 20,000kw. or more.

An experimental 100kw. aero-generator was built by the Russians at Balaclava in 1931. This ran connected to the a.c. network and was intended as a pilot plant for much larger units to be developed by the Central Wind Power Institute established at Moscow soon after the First World War. Since then many smaller machines have been installed in Russia to supply power for agricultural communities.

A 1,250kw. aero-generator for use connected to the a.c. network in Central Vermont, United States, was built during the Second World War, and this ran satisfactorily in commercial operation for a short period before the breaking of a propeller blade caused its abandonment.[2] Other design studies for wind-driven machines of 1,500, 6,500 and 7,500kw. were made in the United States during the Second World War.[3,4]

The recent resurgence of interest in wind power generation is due to a number of causes. Among these are the costs of fuels and their high rate of exhaustion in some countries, the need for alternative sources of energy in countries where the end of the exploitation of economic water-power sources is in sight, the desire for independence of imported fuels and the urge to make fuller use of some of the under-developed areas of the world where a mains supply of electricity would be out of the question in the early stages of development.

One can recognize, therefore, three scales in the possible use of wind power: (a) small scale, by 0.5 to 10kw. sets, for isolated single premises, (b) medium scale, by 10 to 100kw. plants, for communities which cannot otherwise be supplied economically, and (c) large scale, by generators, having a unit capacity of up to 1,500kw. or more, used as fuel savers through the energy fed by them into a main network.

WIND-POWER CHARACTERISTICS

The characteristics of the wind as a source of power, and of annual energy, are considered below with particular reference to the bearing which they have on the operating range of wind speeds to be chosen in design of wind-driven machines.

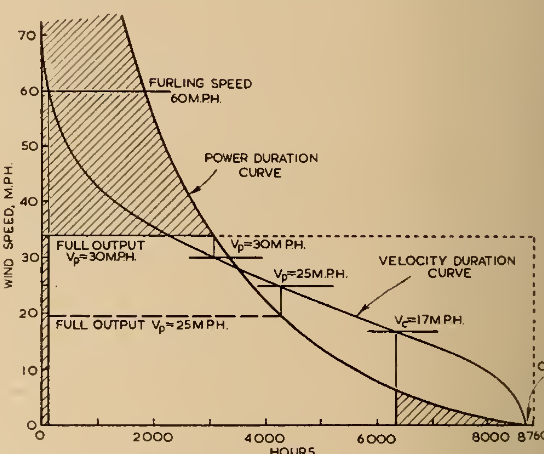


Fig. 1. Velocity- and power-duration curves for a wind-power site.

The Extraction of Power by a Windmill

The power in a wind stream of cross-section A and moving with velocity V is $\frac{1}{2}(\rho AV)V^2$, or $\frac{1}{2}\rho AV^3$, where ρ is the density of the air. Expressing the power in kilowatts, A in square feet, and V in miles per hour, and using for ρ the standard value of 1,201g/m^3, (at a barometric pressure of 1000 millibars and 290°K) the formula for the power becomes.

$$P = \frac{5}{10^6} AV^3$$

Thus, when the wind speed is 30 m.p.h., for example a windmill rotor of 50 ft. diameter is met by a column of air the power in which is 265kw. But the rotor cannot extract all this power. Betz, of Gottingen, has shown[5] that the fraction which can be extracted, called the power coefficient, C_p, has a maximum value of 16/27 (or 59.3%). Mechanical losses, and those in the generator and control gear, further reduce the power output from the wind-driven machine so that the "overall power coefficient," C_{op}, may not greatly exceed 40%. Since the wind is a free source of energy the low power coefficient is not directly important; a reduction of the power output to 40% can be corrected by increasing the rotor diameter in the ratio $\sqrt{(2:5)}$: 1. Indirectly, therefore, the effect is to enhance the cost of the windmill because of the larger rotor which is needed. This, together with the initial disadvantage of the low density of the air, constitutes one of the two main difficulties in using wind power economically. The other is the inconstant nature of the wind.

The counterbalancing advantages of wind power are that it is an inexhaustible source of energy which is abundantly available in many parts of the world, and that its utilization, up to the maximum degree which may be feasible, is not likely to be detrimental to the region concerned through the occupation of valuable land or otherwise.

Although, even in very windy places, one cannot rely upon wind at any given time, the variations in the annual average wind speed at a site do not generally exceed ± 10% of the long-term mean. Wind is therefore a dependable source of energy but an unreliable source of power.

At sites with an annual average wind speed approaching 30 m.p.h. there are sometimes calm periods of several days' duration, while almost windless places have their occasional hurricanes.

The annual average wind speed is the best guide to the energy which may be obtained, and this varies over the world from about 2 m.p.h. to

50 m.p.h. At most of the places where the economic use of wind power may prove feasible the wind régime, as expressed by the velocity-duration curve (see Fig. 1), takes the same general form with small percentages of calms and of hourly wind speeds above 60 m.p.h. When the wind is gusty its instantaneous speed may change 50 to 100% within 0.5 sec. Gust speeds do not seem to be related in a direct way to the annual wind speed, so that although gusts of 125 m.p.h. were recorded (in January 1953) at the E.R.A. testing site on Costa Hill, Orkney, where the annual speed is 25 m.p.h., gusts of over 90 m.p.h. have been measured, for example, at observation stations in India, Australia and South Africa — regions which are normally much less windy than Orkney. The inference is, therefore, that wind-power plants must be designed to withstand high wind pressures no matter where they are to be installed.

It is of interest to examine wind records to determine whether any regular pattern can be recognized in wind behaviour. Taking monthly mean wind speeds first, these may vary from the yearly mean sometimes by as much as 30 or 40%, but very seldom does one find a station which has a reasonably high annual wind speed and yet has some months which are consistently calm. In Great Britain and many other parts of the northern hemisphere, January is the windiest month and July and August the least windy.

There is a rather more pronounced pattern in the diurnal variations of wind speed. Thus, at coastal meteorological stations situated on the continental land masses — as, for example, in India or South Africa — throughout the year there are higher wind speeds during the period from noon to early evening, with lower winds during the night. These effects are caused by temperature differences between the land and sea; as the ground warms up there are rising air currents which draw in air from the cooler sea. Land and sea breezes — the former during the night and the latter during the day — may extend to about 10 miles inland in temperate climates, but even 60 miles or more in some tropical regions.

At the sites selected for wind-power studies in Great Britain it is impossible to distinguish any regularity in the diurnal variations; high winds appear as likely to occur during the night as in the daytime. The probable explanation is that diurnal variations are so often masked by storms.

The conclusion to be drawn is that, while in some parts of the world some reliance can be placed on the occurrence of wind each afternoon, in others, such as Great Britain, the wind must be accepted as truly random.

It has been suggested, particularly by Thomas,[6] that some firm power may be obtained through the effect of diversity when wind-driven generators, on widely separated sites, are connected to an extensive network. It is true that the output from a number of interconnected machines is steadier than from a single one, but examination of the wind records from E.R.A. wind-power sites during the past six years shows that a spell of calm weather often covers a large area, so that all the machines would sometimes be out of operation at the same time.

Wind direction is another factor which may have importance in choosing a wind-power site. There is often misconception about the expression "prevailing wind." The direction of this is that direction from which the wind blows for the greatest percentage of the year, but (taking the eight principal directions) this may be only some 15 or 16% as compared with the 12½% which would be the average duration for each direction if the wind were uniformly distributed. There are a few regions, as, for example, the Rhône valley and around Aqaba Bay at the southern end of the Wadi Araba, where the prevailing direction is very marked. At Eilat, on Aqaba Bay, the wind is from the north or north-east for 78% of the year. For such sites there is the possibility of using a non-orienting — and, perhaps, cheaper — windmill without incurring much loss of energy throughout the year.

Annual Energy Output

The annual output of energy from a wind-driven generator of given capacity depends mainly on (*a*) the wind régime at the site, and (*b*) the operating range of wind speeds chosen in designing the machine.

The velocity-duration curve for a site, drawn from an analysis of the measured hourly wind speeds there, gives the number of hours in the year during which the speed equals or exceeds any particular value. Fig. 1 shows the velocity-duration curve for the E.R.A. wind-measuring station at Mynydd Anelog, in Caernarvonshire (annual average wind speed, V_{am}, is 26 m.p.h.). The power-duration curve shown is obtained by cubing the ordinates of the velocity-duration curve.

It would be uneconomical to design an aero-generator to operate over the whole range of wind speeds. The machine is designed to cut-in at low wind speed, V_c, at which its output is merely sufficient to supply its own power losses. At the rated wind speed, V_p, which is chosen to be some 5-10 m.p.h. higher than V_{am} for the site, the plant produces its full rated power, while for high wind speeds, up to the furling point, V_f, when it may be shut down to avoid damage, the output is controlled to the full rated value, P_c. The control is by some form of governor, which, in effect, spills the excess power. Referring to Fig. 1, the unshaded area lying under the full-output line and the power-duration curve over the operating range is proportional to the annual output of energy. The specific output, T_s, expressed in kilowatt-hours per annum per kilowatt, is the equivalent number of hours at full output. It is obtained by dividing this area by that of the surrounding rectangle (shown broken). Specific output is a function of the shape of the power-duration curve and of the operating range of wind speeds used. It is thus reasonable to speak of the specific output of a site as *x*kwh/year/kw. for a rated wind speed of *y*m.p.h.

There is, of course, the implication that the overall power coefficient, C_{op}, is constant over the operating range from cut-in to rated wind speed. This is not quite true — since

TABLE I

Operating range			
Cut-in speed, V_c	Rated wind speed, V_p	Furling speed, V_f	Specific output, T_s (V_{am}=26 m.p.h.)
m.p.h.	m.p.h.	m.p.h.	kwh/year/kw
24	45	60	2 000
21.5	40	60	2 600
18.5	35	60	3 400
17	30	60	4 400
13	25	60	5 500

the output is obviously zero at V_c — but the power co-efficient/wind-speed curve is flat-topped so that C_{op} does not fall appreciably until the power output is down to about $P_c/3$. The effect of this upon estimates of annual energy output made from wind measurements is therefore usually negligible; this is particularly true at a very windy site when some two-thirds of the annual energy may be given by winds of rated speed or above.

It is probable that the characteristics of the output-controlling mechanism (usually blade-pitch changing) will have a greater effect upon the energy obtained. Power fluctuations in a gusty wind are considerable in magnitude and unpredictably variable in rate. Even with full knowledge of the performance of the controls to be used, the output from a gusty wind may be calculated only with difficulty; without such knowledge precise estimates are impossible. The energy output under gusty conditions will depend on the rate of response of the controls in relation to the fluctuations of wind power, so that the power output of the machine for a given mean wind speed is not quite constant — it will vary with a "gustiness-factor," an agreed definition of which has yet to be found.

The effects mentioned above may, however, be considered rather as of secondary importance. To return to the more important question of choice of the operating range, consider a change in this range as indicated on Fig. 1, where the effect of a reduction of V_p from 30 m.p.h. to 25 m.p.h. can be observed. This effect is a great reduction of the annual output of energy from a machine with a given rotor diameter But this is accompanied by an increase in T_s, as represented by the ratio of area under the power curve to the area of the surrounding rectangle. Table I shows how T_s varies with the operating range of wind speeds chosen in the design of the machine.

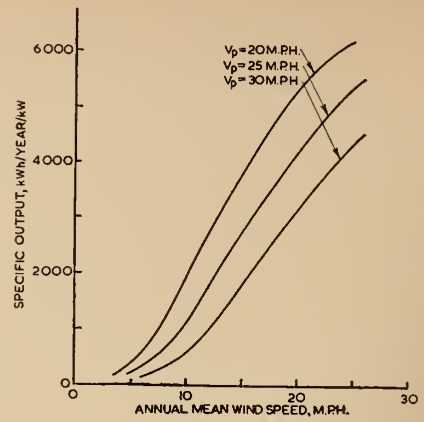


Fig. 2. Relationships between specific outputs and annual mean wind speeds.

The lower the rated wind speed the higher the specific output but the larger the rotor for a given power capacity. Obviously, from the power formula in Table I.

$$\text{Rotor diameter} \propto \sqrt{\left(\frac{P_c}{\rho V_p^3}\right)}$$

Relationship Between Mean Wind Speed and Specific Output

As the work of analysing the wind records from selected measuring sites in Great Britain progressed, it became clear that the velocity-duration curves were all of similar shape, especially over the range which might be employed for wind power. A very important fact thus emerged, namely that V_{am} for a site could be accepted, for estimation purposes, as a sufficiently accurate — though indirect — measure of the specific output. The curves shown in Fig. 2 were drawn, and almost all the wind régimes so far studied — including those for places abroad — conform to them. There may be a few exceptions for stations characterized by unusual percentage durations of very high winds or of calms.

The importance of this for wind survey work is easy to understand; a simple counter instrument measuring run-of-wind, in miles, from which the mean wind speed is easily calculated, can be used for most of the measuring stations, instead of a more complicated and expensive wind-recording equipment giving hourly wind speeds which must subsequently be classified from analysis of the records.

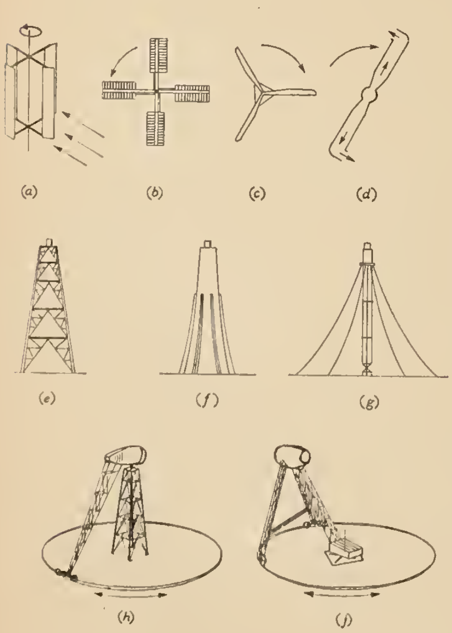


Fig. 3. Features of windmill construction.
V_p = 30 m.p.h.
(a) 50 ft high and 20 ft. diameter for 10 kw.
(b) 60 ft. diameter for 35 kw.
(c) 100 ft. diameter for 500 kw.
(d) 80 ft. diameter for 100 kw.
(e)—(j) Tower height = ½ (dia. of blade circle) + 30 ft.

WIND-DRIVEN MACHINES

To obtain power from the wind one must place in its path a machine which, by retarding it, can extract some of the kinetic energy contained in the passing air. A sailing ship receives its driving power as a simple product of its linear motion, with the wind, and the wind pressure on the sails, but a stationary machine can capture the power only by rotation about an axis which may be vertical or horizontal. Its structure must withstand the full force of the wind because there is no relief, as in the sailing ship, through relative motion.

Types of Windmill

Since the first machine driven by the wind was made, many centuries ago, literally thousands of individual designs must have been invented. Their number is still growing; some modern inventors are "re-inventing" types which were familiar to the ancient Persians. But all can be placed in one of two main classes, namely:

a) *The solid type*, with the effective surfaces of the rotor moving in the direction of the wind.

(*b*) *The propellor* (*or wind-wheel*) *type*, with the rotor rotating in a plane perpendicular to the wind.

The solid type — machines so called because they interpose continuously, in the path of the wind, active rotor surfaces [see Fig. 3 (*a*)] which almost fill the cross-sectional area of the column of air acted on — as distinct from the propellor type, in which only a fraction of the swept area is occupied by rotor surface. Another name for this type is the "panemone."[8] A cup anemometer is a simple example.

Usually, although not necessarily so, they have a vertical axis and the rotor has paddles, or moving vanes, the shape, number and arrangement of which is very variable. They can receive wind from any direction without the need for orientation, but, while the paddles on one side, moving with the wind, are urged forward by it, those on the other side, returning against the wind, are subjected to a back pressure unless this is removed by some form of screening or by turning them edgewise as they meet the wind. The paddle surfaces, moving in a circular path, are not all subjected at the same time to the full wind pressure, and there is a screening effect of one on another. It can be shown also that the maximum theoretical power coefficient of a panemone is 0.33 (as compared with 0.593 for a propellor type of rotor). The actual power coefficient is thus low.

Further, since the active surfaces must always run at a speed lower than that of the wind, the rotational speed—which falls with increasing rotor diameter — is low so that expensive gearing is needed if a high-speed electrical generator is to be driven.

The panemone is not, therefore, a promising type for electrical purposes of any appreciable scale, although crudely-constructed machines of this type, having a wooden framework and rush mats for the moving vanes, still serve a useful purpose in pumping water or brine in parts of China and other eastern countries. It has to be borne in mind that efficiency (or power coefficient) is not the main criterion when the input power is free; low initial cost for a machine which operates satisfactorily is the prime requirement, and this can sometimes be met, in small-scale work, by one of the panemone type.

Propellor type. — While the active rotor surfaces in the type of machine just described are struck perpendicularly by the relative wind velocity (wind velocity minus the velocity of active surface) those in the propellor type make only a small angle (the angle of attack) with the direction of the relative wind and they rotate at much higher speed [Figs. 3(*b*) and 3(*c*)]. The rotational speed increases as the number of blades is reduced. Two or three blades are used for the high-speed machines generating electricity. The optimum power coefficient is obtained at a value of the "tip-speed ratio"

$$\mu o = \frac{\text{peripheral speed of blade tip}}{\text{wind speed}}$$

which varies from about 1 in the slow-running multi-bladed rotor used for water pumping to 2.5 for the old-fashioned 4-bladed windmills, and 6 or more for high-speed aero-generators.

When a wind rotor drives an a.c. generator connected to a constant-frequency network, it must run at constant speed, hence the tip-speed ratio must vary with the wind speed. Optimum power coefficient can then only be maintained (approximately) by variation of the blade pitch, but the cost of control gear needed to vary the pitch with a continually-varying wind speed is probably not justifiable. It may be better to accept the small reduction of power, from this cause, over the operating range of wind speed, and to use pitch-changing — if at all — to control the power output for wind speeds above the rated value V_p. The Danish experimental aero-generator of 45kw. capacity installed in 1953 by the South East Zealand Electricity Supply Company,[1] follows this principle; its blade pitch is set to match the most frequent site wind speed.

The maximum power coefficient obtainable, in practice, with a high-speed rotor of the propellor type is probably a little over 0.5, which would give an overall power coefficient, C_{op}, of approximately 0.4.

Features of Recent Designs

In Table II the main features of several designs for a large or medium scale aero-generators of the propellor type are compared.

It will be observed that the design capacities range from 45 to 7,500kw. (with twin rotors) for rotor diame-

Table II

Item	Design	Rotor diameter	Rated wind speed Vp	Generator	Form of rotor	Control of speed or output	Optimum tip speed ratio	Rotational speed of rotor	Height of hub above ground	Method of weather-cocking
		ft	m.p.h.	kw				r.p.m.	ft.	
(i)	Russian (Balaclava)	98	24.6	100 (Induction generator)	3 blades	Variable pitch by flaps	4.75	30	76	Tail vane and electric drive
(ii)	P. H. Thomas (United States Federal Power Commission)	200	34	7500 (d.c. converted to a.c.)	Twin, 3-bladed	Speed control through generator field	9	Variable maximum 42.75	475	Electric drive
(iii)	United States War Production Board	200	30	1500 (Induction generator)	2 blades	Blade pitch control; electro-mechanical system	12	50	150	—
(iv)	Smith-Putnam	175	30	1250 (Synchronous generator)	2 blades (Rectangular form)	Hydraulic pitch control through fly-ball governor	6	29	110	Yaw vane. Servo-mechanism. Hydraulic yaw motor
(v)	Folland (Ministry of Fuel and Power)	225	35	3760 (Induction generator)	2 blades, 2 stage taper, 11½° twist, fixed coning	Blade pitch control by aileron. Start/stop by pilot wind-mill	9.74	42.5	135 (tripod)	Fantail coupled to bogey wheels through centrifugal clutch on fluid flywheel.
(vi)	John Brown	50	35	100 (Induction generator)	3 blades, tapered, untwisted. Free to cone and drag	Hydraulic control of blade pitch	6.5	130	78	Automatic electric control
(vii)	Enfield Cables	80	30	100 (Synchronous generator)	2 hollow blades	Automatic pitch control by hydraulic system. Variable coning	—	Variable maximum 95.4	100	Self-orienting but assisted by wind-sensitive power control system
(viii)	S.E.A.S. (Danish)	43	23	45 (Induction generator)	3 blades	Blade-tip rotation, spring controlled	5.4	56	66	Yawing vane and electric motor drive

ters of 43 to 225 ft. and rated wind speeds of 24.6 to 35 m.p.h. There is agreement on the number of blades as 2 or 3, and variation of blade pitch is used in most designs. The S.E.A.S. machine has braced blades with fixed pitch except that the outermost portion of the blade can rotate through 45°, under spring control, so acting as an air brake. Thomas's design[4] with twin rotors also has fixed-pitch braced blades, and the rotors, running at variable speed, drive a d.c. generator feeding its output into a convertor.

The generators are most commonly of the induction type, which is robust and is stable in automatic operation, although Putnam[2] used a synchronous generator for the Grandpa's Knob aero-generator, and this type is used also in the Enfield machine.

Another possibility which has been suggested, although so far as the author is aware it has not yet been incorporated in an aero-generator, is an a.c. commutator generator running at variable speed yet supplying constant frequency.

Smaller blades may be made of solid or laminated wood, but for the larger blades stainless steel and aluminum alloy are the most probable alternatives. For the highest efficiency the blades should have a twist and should taper, but the inner portions, near the hub, contribute little to the total power, and the higher cost of such blades, as compared with that for rectangular plan-form blades, may not be worth incurring. To relieve the stresses at the roots of the blades under fluctuating wind conditions they may be flexibly mounted so that they can "cone" or "drag."

Starting and stopping may be done through a small pilot wind-mill which initiates adjustment of the blade pitch according to the predetermined limits of operating wind speeds.

Except in very small fast-running machines, the high rotational speed needed for the generator is attained through gearing. There is usually a gear-box aloft in the nacelle which houses the generator, but some medium-sized machines — such as the Danish Lykkegaard windmills—have a vertical driving shaft running down inside the tower with bevel gears at top and bottom. Alternatives to gearing, which is expensive and may prove a limiting factor in the construction of very large machines, have been proposed. Some large German designs show two contra-rotating propellers, one carrying the rotor of an alternator and the other its stator, but such a scheme would appear to introduce difficulties in operating with an economically short air-gap.

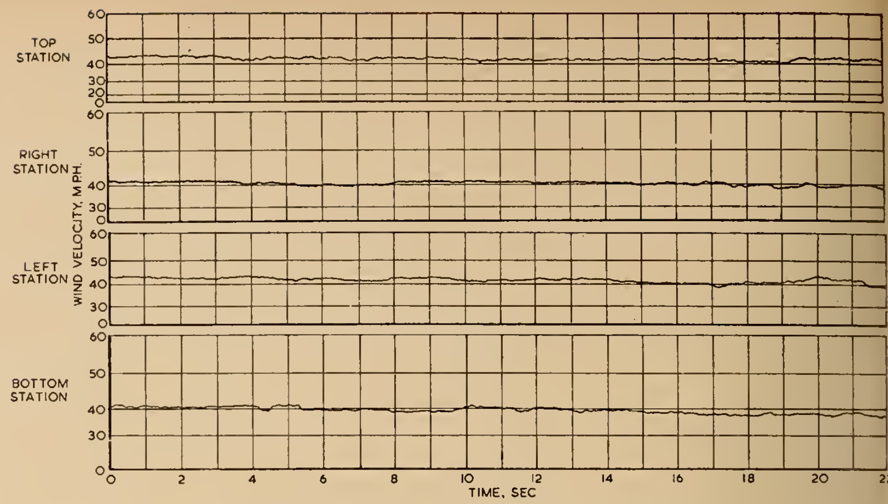


Fig. 4. High-speed records of wind-speed distribution.

The Andreau principle of pneumatic power transmission [see Fig. 3 *(d)*] is interesting. Air is thrown out centrifugally from the blade tips, and the depression created drives an air turbine at the base of the supporting tubular structure. Power losses must be incurred in the double conversion of energy from aerodynamic to mechanical form, at the top and bottom, but there are advantages in having the machinery at ground level and in the lack of any specific relationships needed between the speed of the rotor, the generator and the wind. Rapid changes in torque due to gusts may be damped out.

The form of the supporting structure for windmills is open to considerable variation according to the ideas of the designer. A few possibilities are shown in Figs. 3*(e)*, *(f)*, *(g)*, *(h)* and *(j)*. The tripod design of diagram *(h)* has advantages in allowing the head of the aero-generator to be assembled at ground level and then raised, using two limbs of the tripod as shear legs. It also allows the slip rings to be housed in the central building instead of aloft.

RESEARCH AND DEVELOPMENT

For the successful exploitation of wind power it is necessary to:

(a) Find windy sites;
(b) Make an aero-generator to operate satisfactorily;
(c) Test the performance of the machine;
(d) Study the methods of loading to ensure that the available wind energy is fully utilized.

The E.R.A. wind power research programmes have been based upon these four requirements. First, as part of its rural electrification work, and with financial support from the Ministry of Agriculture and Fisheries, research on the small-scale use of wind power for isolated premises was started. This had the twofold object of finding, through performance tests on existing small windmills generating direct current, the most satisfactory one for use in the windy — and often remote — districts of Great Britain, and of determining the best methods of loading to utilize the available wind energy in the fullest possible degree.

Then, as interest in the possibilities of large-scale a.c. generation grew, research on this subject began in 1948 under a newly-established committee on wind-power generation. The initial assumptions[9] were, first, that a number of sites could be found which were windy enough for a specific output of 4000 kwh/year/-kw. to be obtained from an aero-generator with a rated wind speed of about 30 m.p.h., and secondly, that suitable large machines, to be operated automatically when feeding their output direct into main networks, could be built, in quantity, for about £50 per kilowatt.

These two assumptions, if proved to be justified, would make a *prima facie* case for large-scale wind power by leading to an energy cost of 0.25d. per kilowatt-hour — as compared with rather more than 0.4d. per kilowatt-hour for the fuel component of generating cost at coal-fired steam power stations.

The progress made during the first six years is summarized below.

Wind Surveys and Wind Structure

Meteorological Office data on wind regimes for observation stations in Great Britain were studied, and analyses were made to relate them to wind-power possibilities.[10] Following this preliminary work, wind surveys were started in the especially windy western coastal districts. The first were in Orkney, Wales and Cornwall, followed by others in Shetland, the Hebrides and West of Scotland and, later, in Northern Ireland, the Republic of Ireland, the Isle of Man and the Channel Islands. In all, more than 100 measuring sites have been used.

These sites have been chosen mainly on the summits of well-exposed smoothly-shaped hills without precipitous faces and with no trees or other obstructions to disturb the wind flow over them.

With the valuable aid of local observers, wind measurements have been made by counter-type cup anemometers, mounted on 10 ft. poles and giving the run-of-wind, in miles, at most sites. On others, 30 ft. poles, carrying electrically contacting cup anemometers and used with specially-built recorders,[11] have been installed. These give hourly winds speeds from which velocity-duration curves are plotted. Comparisons are made with the long-term records from local Meteorological Office stations.

At a few sites 70 ft. masts, carrying anemometers and wind-direction indicators at different heights, have been used with photographic and impulse recorders to determine the vertical wind gradients over the hill summits.

Located in districts with mean annual wind speeds ranging from 12.5 to 17.5 m.p.h., the chosen sites have been found to have mean wind speeds of up to 29 m.p.h. Out of 65 hill sites, of altitudes from 150 ft. to 2,795 ft., 39 have annual mean wind speeds exceeding 20 m.p.h., with estimated specific outputs (for V_p = 30 m.p.h.) from 3,000 to 4,750 kwh/year/kw (see Fig. 2).

In the areas surveyed, only representative hills have been selected; doubtless there are many others equally windy.

Experimental studies of the vertical wind gradient have shown that over a hill summit the mean wind speed increases with height less rapidly than over level ground. Mean hourly wind speeds for the highest and lowest points on the circle to be swept by a large rotor are not likely to differ by more than 10%.

Fig. 5. 120 ft. rotatable mast used for wind measurements on Costa Hill, Orkney.

Gust anemometers[11,12] have been developed for use with quick-response recorders to measure gusts with a 0.1-sec. response. A balsa-wood windmill - type anemometer, used with an electronic counter, has also been built to measure mean wind speeds over periods of a few seconds.

Measurements with these instruments have indicated that:

(*a*) In a gusty wind of mean speed 40 m.p.h. the short-period mean speed may vary between 20 and 84 m.p.h. and the rate of change of wind speed in a gust may exceed 120 m.p.h./sec. (e.g. 52 m.p.h. to 85 m.p.h. in ¼ sec.).

(*b*) The energy contributed by a gusty wind (as calculated by cubing short-period mean speeds) is not likely to exceed that calculated from hourly mean speeds by more than 2 or 3 per cent.

(*c*) The vertical component of the wind velocity, affecting an aero-generator located on a hill summit, will usually be small.

(*d*) There are periods, of perhaps 10 sec., when the distribution of wind speed over the circle swept by a rotor of, say, 60 ft. diameter will be uniform to within ± 2 m.p.h. This is supported by the gust anemometer records shown in Fig. 4. They were obtained from instruments mounted at 110 ft., 80 ft. (at the two ends of the cross-arm) and 50 ft. on the rotatable measuring mast at Costa Hill, Orkney (see Fig. 5).

(*e*) At the summit of a roughly conical hill the direction of the wind does not influence the preceding statements significantly.

In an endeavour to obtain information to guide the selection of wind-power sites, laboratory work has been done using scale models of hills in an electrolytic tank. The distribution of current in the conducting solution above the model is taken as analogous to wind flow over the hill, but the analogy is by no means perfect and the useful information to be so gained may be rather limited.

Aero-Generator Prototypes and Pilot Plants

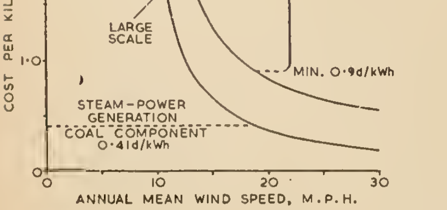
The construction and operation, with an a.c. network, of wind-power plants of significant size lay outside the normal scope of E.R.A researches. This important part of the work was undertaken by the North of Scotland Hydro-Electric Board and the British Electricity Authority; both placed orders for 100kw. wind-driven generators. These are of different types, the main features of which are given in items (vi) and (vii) (respectively) in Table II.

The first experimental machine was erected during 1951-52 on Costa Hill, Orkney, and has since been subjected to a number of trials. There are many difficulties, some of an unexpected nature, to be overcome in the development of a machine of this kind and in its operation on a very exposed site where the weather conditions are often severe. It is not surprising, therefore, that modifications have had to be made as a result of the trials. These modifications have been connected particularly with the methods of blade mounting and pitch control. For technical reasons, also, the blade-circle diameter has been reduced from 60 to 50 ft., while the rated wind speed has been increased from 30 to 35 m.p.h. which is more economical under the wind régime at Costa Hill. Since its erection the structure has withstood several very severe gales without damage. The machine has generated its full rated output during test and has been subjected to loads of up to 150kw. for short periods. It has run in wind speeds up to 70 m.p.h. Following the experience gained, its manufacturers are now undertaking the design of a 250kw. aero-generator.

The 100kw. Andreau-type aero-generator being made for the British Electricity Authority has been built and subjected to some preliminary trials at St. Albans prior to its installation on its final site.

In Denmark, during the same period of development, two machines, the first of 13kw. and the second of 45kw. capacity [Item (viii) of Table II] have been built and tested.[1] These have run satisfactorily for more than 12 months connected to a.c. networks. Their specific outputs have been just under 2,000kwh/year/kw, at sites with annual mean wind speeds of 11 m.p.h. — performances estimated from wind measurements.

Fig. 6. Curves of energy costs for medium- and large-scale utilization.



For use on farms and at isolated premises, two wind-driven machines of 8-10kw. capacity have been developed. The first, with a rotor diameter of 8 metres, is of the Andreau type, and the second, which is now on the market, is a German machine of more conventional design. It has a rotor diameter of 10 metres and produces 8kw. in a wind of about 25 m.p.h. Tests[13] have been made with this machine driving an induction generator connected to an a.c. network.

TABLE III

Machine	Capacity	Diameter of blade circle	Tower height	Total weight
	kw.	ft.	ft.	tons
Conventional type (*a*)	10	20	45	1.1*
	100	50	80	20
Conventional type (*b*)	8	33	33	1.4
Andreau type	10	28	61	2.8
	100	80	100	40.5

* Without the tower.

Design Studies and Performance Tests

During the past six years a vast amount of information on wind power has been obtained through correspondence and the exchange of visits with engineers abroad, particularly in Denmark, France, the Netherlands and Germany. International co-operation has been organized through a wind-power committee of O.E.E.C.[14] and through the Arid Zone Advisory Committee of UNESCO. More than fifty countries appear to be seriously interested in wind power and several have instituted wind surveys to provide data for the designers of wind-power plant and to serve as a guide to the possibilities of utilizing this form of power.

Many, and very varied, designs have thus come to light and the need for design and utilization studies has become obvious.

The Ministry of Fuel and Power started to give financial support to wind power development in 1949-50 and put in hand a comprehensive design and costing study to determine the best lines of constructional development to be followed, and also the probable costs of large wind-driven machines.

A suggested design emerged from this study [see Item (v), Table II] and, based on January, 1951, prices and on the wind régime at Costa Hill, Orkney, a generating cost of rather under 0.2d. per kilowatt-hour was estimated.

The Ministry have also supported E.R.A. work on the testing of the two 100kw. pilot plants already referred to. At Costa Hill, Orkney, a rotatable 120 ft. mast (Fig. 5) carrying gust anemometers and other wind-measuring instruments has been installed, together with electrical instruments to obtain both short- and long-period measurements of output from the aero-generator, corresponding to different wind conditions. A 70 ft. measuring mast and similar testing equipment have also been provided for tests on the B.E.A. 100kw. machine.

In addition, a windmill testing station has been established at Cranfield, Bedfordshire, close to the College of Aeronautics. Here a number of small windmills of different types up to 10 kw. capacity are being tested in the same wind régime, and a series of investigations will be made to test the effects of artificially-created, irregular conditions of operation. The object is to provide information for aero-generator designers and to test the possibilities of a very simple and cheap construction.

Also at the Cranfield station, in conjunction with tests on small windmills in normal operation at remote premises, studies are being made of the methods of loading best suited to the fullest utilization of the annual energy becoming available. This work is particularly of interest to the Ministry of Agriculture and Fisheries, which support it financially.

The Economy of Wind-power Utilization

The cost of energy production by wind power is governed by the annual charges for interest, depreciation and maintenance of the plant, on one hand, and by the annual energy output on the other. The economy can be judged only by comparison of this cost with that for alternative means of energy production.

Where electrical energy is cheap, large wind-driven machines must be located at sites with high mean wind-speeds if they are to be competitive, but where generating costs are high, smaller machines and lower wind-speeds may prove economically practicable. Thus the question of economy is relative rather than absolute. It is closely connected, also, with the cost of providing storage to cover calm spells. Storage of energy by a battery, or by any other means involving the provision of equipment which serves no other purpose, is expensive, and, even when used in only a limited degree, may double or treble the cost of the energy supplied to the load.

Under most circumstances, however, it is important that every kilowatt-hour of energy generated by the wind-power plant shall be utilized. This calls for its acceptance at the random times of its occurrence, and if storage is essential it should be by means of loads having inherent storage so that no great additional costs are involved in affording it.

The economic possibilities under the three scales of use already mentioned are discussed here.

Small-Scale Utilization

Small wind-driven generators, of perhaps 1 or 2kw. capacity, are usually d.c. machines of low voltage— often not more than 32 volts — and are provided with battery storage to cover calm spells of a few days' duration. Because of the low voltage, they must be located close to the premises to be supplied so that there is not free choice of site to obtain optimum wind conditions. The specific output, even in windy districts may not therefore exceed 1,250kwh/year/kw.

A representative cost, with battery, is £200 per kilowatt, while annual capital charges, enhanced by the short life of the battery, may be 15%. This leads to an energy cost of the order of 6d. per kilowatt-hour, assuming that the machine is operated to make full effective use of the energy generated; probably, in practice, a figure of about 9d. per kilowatt-hour would be more realistic. This cost is high, but, for lighting purposes in a remote district, may not be considered excessive.

A study is being made of the possibilities of using such small machines, without a battery, for the sole purpose of water heating. Matching of the generator and load characteristics is then important, but the advantage may be that the need for a battery is eliminated.

Medium-Scale Utilization

The scope for wind-driven generators in the capacity range 10-100kw. is very varied. They may be used on farms or at other large premises remote from public electricity supplies, to act as fuel savers in supplementing Diesel generation on islands or in isolated districts where small local networks exist, or to act as autonomous, or semi-autonomous, generating plants to supply communities which are being established in many of the under-developed areas of the world.[15,16]

In such places the alternatives of bringing in an electricity supply from outside the area or of generating by Diesel engines may, because of the distances and transport costs involved, be so high as to be almost prohibitive, yet frequently, especially on islands, wind is abundant, so that a sound case can be made for its exploitation. In assessing the economic possibilities it may, in fact, be a question of deciding how low the mean wind-speed can be before the large wind-rotor which it calls for involves installation costs — and therefore annual capital charges — which are too high to compete with the admittedly expensive alternative.

There are, as yet, no firm cost data on which to base estimates of the costs of medium-scale plant in general, but evidence from Germany and Denmark on costs for the lower end of the capacity range indicates £120 per kilowatt (without battery storage) as a reasonable figure. Taking 12% annual charges and a specific output of 2,500kwh/year/-kw., the generating cost, for random energy, would be 1.4d. per kilowatt-hour.

Approximate weights and dimensions for wind-driven generators at the upper and lower limits of this range of capacity are given in Table III.

Fig. 7. The combination of wind power with other power sources.

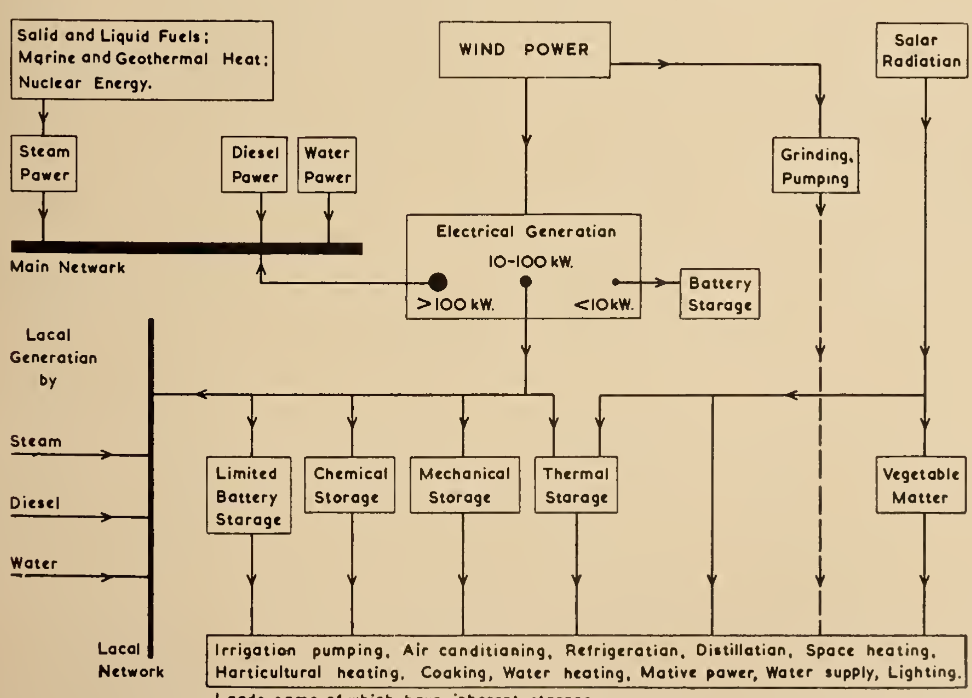


Fig. 8. 100 kW wind-driven generators.
(a) Generator installed on Costa Hill, Orkney (above).
(b) Andreau-type generator at St. Albans, Herts.

The economic possibilities of using such medium-scale plant as a fuel saver, associated with Diesel generation, are illustrated by a curve in Fig. 6 which gives the variation in the costs of wind-generated energy, on this scale, for sites with different annual mean wind speeds. The fuel component for Diesel generation may vary over the range 0.9d./kwh. (where fuel prices are normal) to about 3.7d./kwh. (at places where heavy transport charges cause the fuel cost to be high). From this curve it appears that the economically usable mean wind speed may be anything from about 10 m.p.h. upwards according to the generating conditions.

The costs for random wind-generated energy in this scale seem reasonably low, but if battery storage is provided to cater for even one-fifth of the annual energy to be supplied through it, the total capital charges will be approximately doubled as will also the total cost per kilowatt-hour of energy. Regarded in another way, the energy supplied through the battery will cost at least six times that for the energy which is supplied direct. The uses to which the output of medium-size machines might be put, with or without storage, are shown in Fig. 7. It might be fed direct into a local network which is supplied from another main energy source, and, in addition or as an alternative, it might be used with one of several forms of storage. Only limited battery storage to supply lighting and other small essential loads would be envisaged. The other loads would usually provide their own storage in chemical (electrolytic), mechanical (water pumping) or thermal form or would be such as could be supplied at random times without calling for storage. There may be scope for the hydrogen-oxygen fuel cell as a means of storing wind-generated energy if a practical and economic form of cell results from present researches on the subject.

In some places where communities are established in under-developed areas having ample sunshine, solar radiation would be combined with wind power, particularly for heating and cooking.[17, 18]. Another possibility is the use of waste vegetable matter as fuel, for example, in the small steam engine, the development of which has been sponsored by the National Research Development Corporation. Water pumping without the intervention of electricity generation is another obvious and commonly employed means of using wind power.

Varied utilization for the loads suggested would doubtless demand some planning to distribute the available energy automatically between them according to a predetermined schedule. Thus, for example, when the batteries for supplying the lighting load were fully charged, the generator output could be used for water pumping. This duty, in turn, could be succeeded by a heating load employing thermal storage. Relays, time switches or other physically-sensitive elements could be used for such control, which would appear to be a fairly straightforward matter from the electrical point of view; the planning of the controls to suit the users' requirements would be more difficult.

Large-Scale Utilization [19-22]

Wind-driven a.c. generators used in connection with main networks have the function of fuel savers. Up to the limit of the minimum power demand on the system — a limit high enough to provide ample scope for wind-power development — the output can be fed direct into the network to be used without any question of storage. Clearly the cost per kilowatt-hour of the energy so generated must not exceed the fuel component of generating cost by steam. At present this is about 0.41d. per kilowatt-hour in Great Britain, and from the curve in Fig. 6, a mean annual wind-speed of 18 m.p.h. or more at the site would thus be required for economy of wind-power utilization. This curve is based on a construction cost of £55 per kilowatt for the wind-power plant (which is thought to be reasonable for the largest size of aero-generator built in quantity) and on annual charges of 8½%.

In such estimations it is assumed that the network is sufficiently extensive for the output from large aero-generators, of unit capacity perhaps between 2,000 and 3,000 kw. and built in groups, to be picked up without very high transmission costs between the sites and the network.

It is perhaps worth noting that wind power might be combined very satisfactorily with hydro-electric power. The annual energy output from 500kw. of wind-power plant located at a site where the specific output is 4,000kwh/year/kw. would be equivalent to the potential energy of some 200 million cubic feet of water at 400 ft. head. If adequate water storage were available, some firm power value might be allotted to the wind power through the additional hydro-electric generating capacity which might then be installed justifiably.

Conclusions

To those investigating the possibilities of wind-power utilization it proves a fascinating subject which, admittedly, engenders enthusiasm not unmixed with optimism. Within reason, however, these are not harmful qualities and there are times, in the pursuit of such an elusive quarry as the wind, when they may be useful. There is much to be done before wind power will be able to take its full share in the world's annual production of energy, but the author and his associates in this work do not see insuperable difficulties in the way. In their view, also, the contribution which wind power could make to power production, while certainly limited, is much greater than has been suggested recently by some writers who discuss it as merely an interesting possibility.

Acknowledgments

In conclusion, the author would like to thank the Director of the Electrical Research Association for permission to present this paper and to express his gratitude to his colleagues who have played so large a part in the research work which has been described.

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A Plan for Ontario Highways

A limited edition of a report by the Ontario Department of Highways, described as an engineering analysis of needs on King's Highways and secondary roads, is an exceptionally well-presented publication as well as an indication of the active concern of that province with its highway system (a concern that might well be emulated in other parts of the country).

The report summarizes the results of intensive engineering studies carried out over the two years 1955/56 and is intended as a basis for future planning and expansion that is considered necessary. Presented in five chapters and an appendix, the report shows the inadequacy of the system in relation to population and economic growth, discusses the problems of financing highway work, and goes on to outline a functional classification plan of the highway system into three major classes: freeway highways, and feeder highways. On the basis of the proposed system, plus additional routes for which the province is responsible, a factual engineering appraisal of the needs was prepared. This indicates deficiencies that should be remedied immediately.

As an example, the analysis revealed that 44 per cent of the 8600 miles of King's Highways should have immediate improvement. Of the 1284 bridge structures on these highways, 30 per cent were deficient in width or load-carrying capacity. Of the secondary roads, 60 per cent of the 2400 miles were intolerable because of insufficient width or poor surface condition.

The report is well illustrated with maps, pictures, graphs and tables, and other presentation of data.

Trends in Professional Compensation

Dr. Edward B. Peck

Rutgers University

Presented at the Engineers Joint Council General Assembly, January, 1957.

THERE IS A great deal of interest in engineers' and scientists' pay. The American Chemical Society published a salary survey in 1955 and the Engineers Joint Council presents this survey in January 1957. There have been a lot of publications on the subject that emphasize "telescoping salaries". This means that engineers' salaries do not grow with experience as much as they used to. A similar "telescoping" is observed in merit differentials. This exemplifies what has happened to all middle class salaries. Most of the upper middle class has been squeezed by the social and economic levelling in our economy. Productivity and wages have been rising rapidly, while top salaries have, until quite recently remained static. This has produced the squeeze or telescoping that has reduced experience and merit incentives.

The full paper presents an analysis of engineers' salaries from 1939 to 1956 in relation to the important economic factors: productivity, wages and consumers' costs. It proposes a framework of salary administration that takes account of the factors, experience, merit and the economic trends.

The paper concludes that engineers' salaries have not kept up with national productivity and wages. Probably most upper middle class wages have reacted in much the same way. There are, however, no sound data comparable to that of Engineers Joint Council, except that of the American Chemical Society.

This condition is largely attributed to the attitudes on salaries that prevailed up to about 1952. Salary and wages increases were related to cost of living and cents per hour rather than a percentage increase. Since 1952 the percentage principle seems to prevail.

This is a condensation of a paper presented at the Engineers Joint Council Third General Assembly, in January 1957. The Engineers Joint Council published the results of their salary survey at this meeting.

Another factor in holding down older engineers' salaries was the failure to separate general raises from merit and promotional raises.

It is proposed that salary administration recognize and take account of three independent factors. The first is the secular trend or general increase that is granted to all without regard to individual experience or merit. The next factor is experience, which must be taken account of throughout the whole career. The percentile curves (described below) suggest this trend. Finally, there should be re-established a merit differential that has real incentive value.

A pattern for pricing different degrees of experience and merit is proposed. It is reduced to formulae that start a salary policy, and provide flexibility for changes due to the secular trend.

The graphical treatment of the subject is dealt with in the following sections.

Engineers' salaries, 1956

The 1956 Salary Survey of the Engineers Joint Council, for engineers employed in industry (rather than in government or education) is summarized graphically in Figure 1. The coordinates are salary in current dollars per year and experience is measured in years from first or bachelor's degree (YFD). The curves show the percentile salaries as they vary with experience (YFD). The top line represents the minimum salary of the top 10% of engineers as it varies with experience. The lower lines have the same significance for the other percentiles.

These percentile curves mark out merit levels. Any engineer can spot his 1956 salary on this graph and know what percentile his salary falls in, and he can relate this position to an evaluation of his performance and potential. (Of course there are a lot of correction factors to be applied; for example, all industries do not pay equally well.)

The horizontal lines at $8,300 and $7,600 represent craftsmens' pay. It is considered appropriate to compare engineers' salaries with craftsmens' wages because they are alternate careers for young men capable of becoming engineers. These are the rates in this area for the building trades. They are $4.00 and $3.65 an hour for one year at full time and without overtime. Certain highly skilled crafts in industry are paid

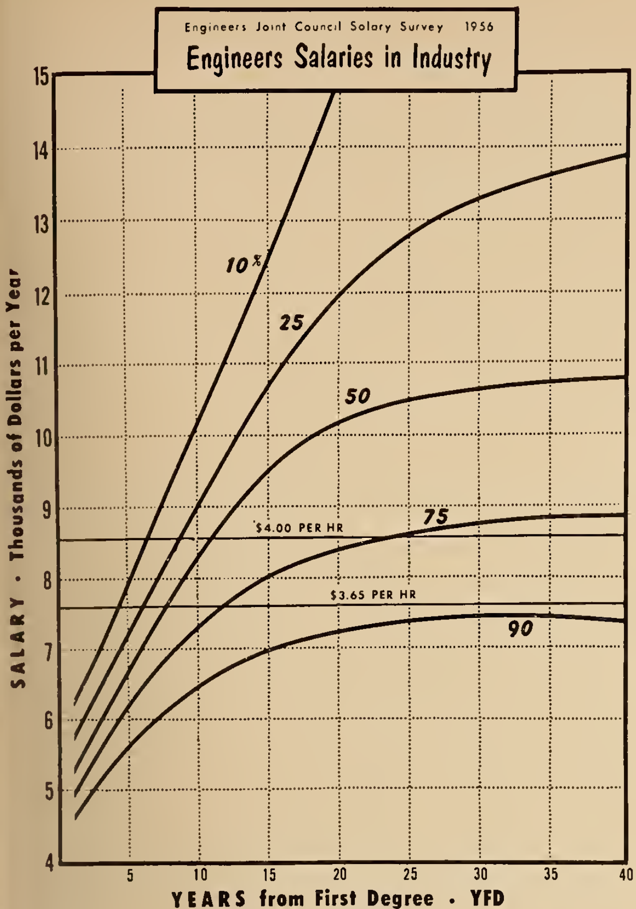


Fig. 1

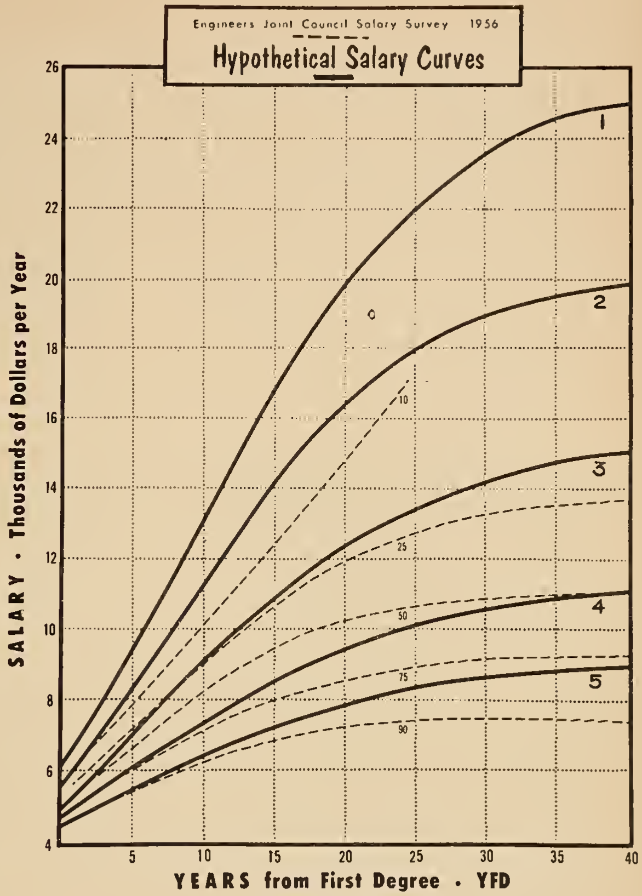


Fig. 2

this much or more, but the statistics are obscured in average hourly rates of industry.

The median salary curve for engineers intersects the craftsmens' wages at 7.5 and 10 years' experience. This means that the average engineer is 30 years old before he catches up in pay with the carpenter and electrician, and it takes two and a half more years to catch up with the plumbers and bricklayers. When the pay represented here is integrated over a career of 43 years (age 22 to 65), the median salary of engineers exceeds the carpenters by about $80,000 and the plumbers by less than $50,000. This is not an attractive return on the investment for an engineering education.

Comparison should be made with management salaries, but the data are limited. It is likely that some elements in industry have done this. Two developments suggest this. First, chief engineers have moved up to be vice-presidents where before they reported to one. Secondly, some companies have adopted parallel levels or advancement that recognize professional competence on a par with executive competence.

A Pattern for Merit and Promotional Salary Administration

A variety of plans have been developed for using a salary survey as a guide in salary administration. The following analysis is based on a plan that has been moderately successful for ten years.

The survey (Figure 1) shows salaries at a particular time; and it shows relationships for merit and experience at that time. When a general salary adjustment occurs, as with wages, and without regard to merit or experience, the survey and salary chart are obsolete. A new one must be made. It is therefore desirable to have a formula for making each succeeding chart.

Salary curves run for a whole career of 40 odd years, and salaries increase with experience for the whole period. It is presumed that the main purpose of merit and promotional raises is to provide incentive for improved and sustained productivity. These incentives should be provided for the whole career.

The curves are guides for distributing merit and promotional raises over a career. They are much clearer than some of the traditional guides. Furthermore, when the curves are expressed as mathematical equations, they can be translated into clear statements of policy.

The next problem is to develop a rational and equitable system for all levels of merit. The analysis of earlier surveys together with an analysis of annual merit and promotional increases as a function of experience, showed that several equations could be used. The one selected says that at any merit level, the annual rate of salary increase is proportional to the salary, multiplied by the amount of money left for salary increases for the rest of the career. This is how the potential idea got into salary administration. These salary curves suggest that each curve is aimed at a goal which is a potential for the employee. This potential had been, perhaps, an unconscious factor in salary administration. This analysis made it a conscious factor in merit rating and professional development. It does not mean that an employee is tagged with a potential early in his career and has to live with it. Periodic merit ratings and performance reviews change these potentials.

The mathematics of this statement is as follows:

$$ds/dt = k\,S\,(A - S)$$

where "S" is the salary, "t" is the experience, in YFD in years, "k" is a constant computed for each curve from the end conditions. "A" is the potential salary or asympote of each curve. The value "A" in relation to the final salary at 40 YFD determines the distribution of raises between the first and second half of the career. Experience shows that when "A" is 3% above the final salary at 40 YFD, theree is good distribution.

The equation is integrated to:

$$\log \frac{A - S}{S} = \log \frac{A - So}{So} - kt$$

And this is the equation of the curves. (This equation is also used to express a variety of other forms of growth).

A set of curves has been calculated as presented in Fig. 2, running from the starting salaries in the survey to $25,000, $20,000, $15,000, $11,000, and $9,000 respectively at 40 YFD. In practice the curves might run from starting salaries to the maximum salaries of job classifications. This relates the curves to the job evaluation system. It also allows for a definition of potential terms of job specifications.

The slopes of these curves which show the annual salary increase along these curves are shown in Fig. 3. It is interesting to note that these slopes of the curves rise to maxima fairly early in the career. In this sense they conform to the productivity curves for outstanding intellectual people as shown in Lehman's book "Age and Creativity".

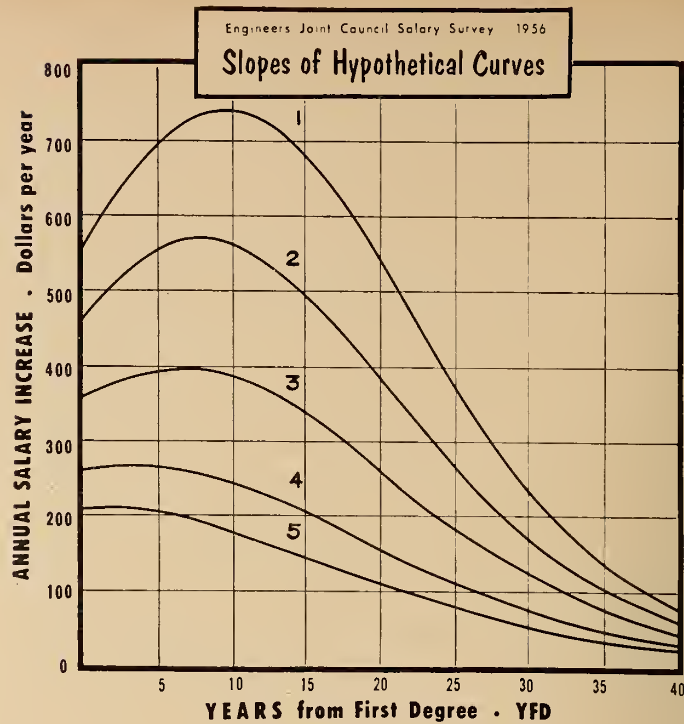


Fig. 3

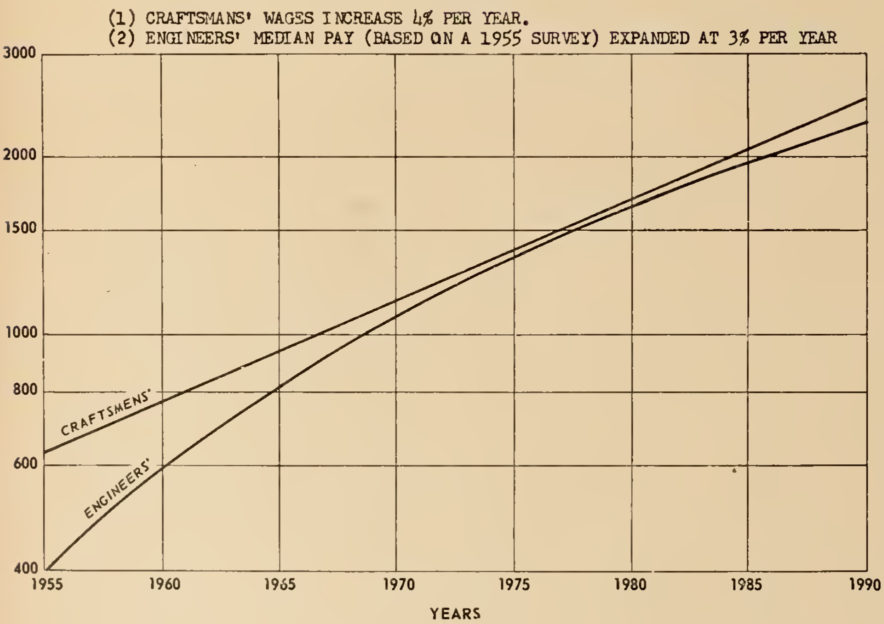


Fig. 4. Projection of comparison of craftsman's pay with engineers' and scientists'. Assume (1) and (2).

Future Annual Meetings

1958

Quebec, Chateau Frontenac, May 21, 22, 23

1959

Toronto, Royal York Hotel, June 8, 9, 10

Henry J. Cambie — Explorer Surveyor Engineer

Canada stands today on the threshold of greatness. When the path to that threshold was still through the wilderness, during the turbulent years which followed Confederation, the political leaders realized the part transportation would play in welding together this new nation, spanning a continent. Their names are history, for they were the dreamers, the planners, the money-raisers. But there were others — who put substance in the deams, translated the plans to reality, got value for the money.

One of these was Henry John Cambie, explorer, surveyor, engineer. His colleagues of a later generation have chosen him for recognition by dedicating a testimonial tablet to his achievement at the Annual Meeting of the Engineering Institute of Canada in June, 1957.

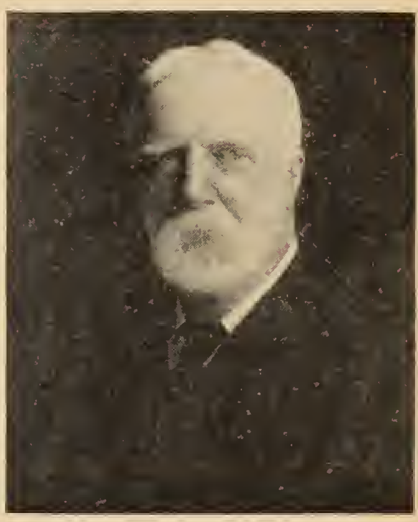
The achievement was the part which Cambie played in locating, surveying and supervising the construction of the Canadian Pacific Railway through the Fraser River canyons. This was the climax, but not the end, of a long and distinguished career which lasted sixty-eight years. From the day of his arrival in Canada, Cambie had prepared for this achievement as inevitably as the waters of the Fraser found their way to the sea.

Henry J. Cambie was born on October 25, 1836 at Castletown, the family estate in County Tipperary, Ireland. He came to Canada with his parents and brother at the age of sixteen. Soon after his arrival, he joined the office of the Toronto and Guelph Railway. From 1853 to 1859 he worked for Gzowski and Co., contractors who were building the western part of the Grand Trunk Railway. He then worked on surveys for the Upper Canada Government and qualified as a Land Surveyor in 1861. He conducted surveys and explorations for the Intercolonial Railway in Quebec, Nova Scotia and New Brunswick from 1863 to 1866. His next job was to survey and supervise the construction of the Windsor and Annapolis Railway in Nova Scotia until 1868.

It was during this period that he courted, won and married Miss Helen Elizabeth Fay. The wedding ceremony took place in Bridgetown, Nova Scotia in 1870. Born in 1848, his bride was educated in Halifax and Boston. She died in 1900.

Canada was still young when British Columbia entered Confederation in 1871. In the negotiations which preceded its entry into Confederation, the new province had stipulated that a transcontinental railway should be built. There were many political considerations. Among them was the question whether the railway should be privately or publicly owned. Sir John A. Macdonald, the proponent of the privately-owned railway, lost the election because of a money scandal involving the contributions to party funds by the syndicate originally formed to build the line. When, three years after British Columbia entered Confederation, there was still no evidence of a start being made on the railway, the premier of the new province protested bitterly. It was then that the Ottawa government proposed immediate construction of a railway — from Esquimalt to Nanaimo on Vancouver Island.

Cambie was sent to British Columbia in 1874 to take charge of this work. But the new province would not be sidetracked and refused to accept the substitute. The project fell through. Sandford Fleming, the chief engineer of the proposed transcontinental railway decided to take a leave of absence. Marcus Smith, in charge of surveys in British Columbia



HENRY J. CAMBIE, M.E.I.C.

returned to Ottawa to replace Fleming. Cambie replaced Smith and took charge of surveys and explorations in British Columbia.

The same year, Cambie visited Burrard Inlet to examine its possibilities as an ocean terminal harbour for the proposed transcontinental railway. One of his recollections of the visit was of being called a "damned fool" for thinking of Burrard Inlet in that connection. There was more opposition to come a few years later.

From 1876 to 1878, explorations and surveys were made continuously under Cambie's direction through all the passes in the Cascade Mountains, from the Pacific coast toward the Yellow Head Pass. The route from Burrard Inlet, via the Fraser and Thompson Rivers, was selected as the most favourable. As already mentioned this choice was not without opposition, as recalled in Mr. Cambie's reminiscences:

"In 1877 while I was in charge of a survey of the line from Yellow Head Pass to Burrard Inlet, the chief engineer, Sir Sandfold Fleming, applied to the Admiralty for reports on the various terminal ports in British Columbia, which it was possible to reach with a railway line, and more particularly on Burrard Inlet. These reports were to be by some of the naval officers who had charted the Coast, many years before, and were then, most of them, on the retired list with the rank of admiral. The naval officer (admiral) then in command at Esquimalt was also asked to report on these harbours. He consulted with people on Vancouver Island who were personally interested in, and partisans of other routes, and by their advice, he made a trip to Yale and the Fraser canyons, and reported that he had inspected the line and could state from personal knowledge, that it was impracticable for a railway. Also that he had been advised to the same effect by prominent engineers and that it was therefore useless to report on Burrard Inlet as a terminal harbour for that line, so he passed it over without a report."

In 1879 the Minister of Railways and the chief engineer decided to postpone construction for another year. Cambie was charged to make as comprehensive a survey as possible of the Peace River country. One of the purposes of this survey was to establish once and for all if the route selected was the right one.

Even as late as 1880, when construction began on the western end of the line, the route to be followed by the railway from Winnipeg to the coast was still in doubt. Sir Sandford Fleming's report of 1880 still showed the route across the prairies angling north-westward from Winnipeg, to pass through Battleford, then considdered the capital of the territories between Manitoba and British Columbia. Yet by December, 1882, the railway had reached the spot which became Moose Jaw and was soon to reach Calgary. The route through the Fraser River canyons, notwithstanding the opposition from many quarters, was chosen.

When talking to the reporter from *McLean's Magazine* in the early 1920's of his experiences as a railway builder, Cambie said: Please make it very clear that, though I explored and surveyed and planned the whole course of the C.P.R. through a large section of the Province of British Columbia, the only part that was built under my direct supervision was that which runs through the canyons of the Fraser."

CONSTRUCTION THROUGH THE FRASER RIVER CANYONS

The route was chosen. The railway would go through the Yellow Head Pass, via the Thompson and Fraser Rivers to Port Moody at Burrard Inlet. Tenders were immediately called for the construction of 128 miles of line to extend from Emory's Bar to Savona's Ferry at the outlet of Kamloops Lake. The job was divided into four contracts, awarded to separate bidders. An enterprising young contractor, Andrew Onderdonk, bought out these contracts. The job was on.

Cambie, who had explored and surveyed the route through the Fraser River canyons and recommended its choice, was appointed engineer in charge of construction for contract No. 60, from Emory's Bar to Boston Bar, which covered the most difficult 29 miles through the canyons.

When Cambie and his engineers had laid out about two miles of line, using four-degree curves and one per cent grades, he received a telegram from the chief engineer to "Locate the cheapest possible line with workable curves and grades". Work stopped. Cambie and his engineers re-examined the terrain in light of the new instructions. While the grades were not increased, the maximum curvature was increased to eight degrees to reduce the number of tunnels as much as possible while maintaining the curvature within the limits considered necessary for a transcontinental railway. Grasshopper trestles, later replaced by retaining walls, were used extensively to reduce excavations and fills.

Labour difficulties were the contractor's headache but they could not help affecting the work of Cambie's engineers who laid out and supervised the work. According to Cambie, "Employment agents in San Francisco sent up men who had never done a day's work before and we often saw broken-down bar-keepers, or men of that class, in cuttings, with fashionable but shabby clothes and perhaps patent leather shoes." Early in 1882, Onderdonk had two shiploads of Chinese coolies sent in, one thousand to each ship. They looked healthy enough when they reached the work site but many soon developed scurvy and the mortality rate was high.

The work was dangerous. The terrain was itself hazardous to work in and the danger was increased by dynamiting and the difficulty of finding safe cover when blasts were set off. There was clumsiness and carelessness.

As work continued the quality of the labour force improved. Cambie was later surprised "at the great number of them who were well-informed men who had drifted through most parts of the world, many of them highly educated. They were good workmen too". The contractor paid good wages, $2.00 and up per day. He provided good sleeping quarters and meals.

Construction through the canyons was completed in 1884. Cambie, who had then been in the service of the federal government in B.C. for ten years, joined the staff of the C.P.R. to take charge of construction from Savona eastward to Shuswap Lake.

As in the Fraser canyons, where one engineer lost his life in 1881, laying out the line was difficult. Cambie recalled that "Quite a stretch of it was laid out by a very small proportion of our engineering staff, consisting of two sailors, who strung ropes from rock to rock or from tree to tree, and a few engineers, who, steadying themselves with these ropes, went along in their bare feet to lay out the work, with a precipice and then Kamloops Lake of unknown depth immediately below them." The tracks from the West met those from the East on November 7, 1885, at Craigellachie, 350 miles from Vancouver.

The occasion was marked by a morning ceremony attended by Sir Donald A. Smith (later Lord Strathcona), Sir William van Horne, Sir Sandford Fleming with Marcus Smith representing the federal government, M. J. Haney representing the contractor, and Cambie and Rogers representing the railway engineers. The photograph of the ceremony, usually titled "Driving the Last Spike" has probably been reproduced more times than any other Canadian picture. It is in many books of Canadian history. The practice, then prevalent in the United States, of using a gold spike for the ceremony was not followed. In his poem "Toward the Last Spike" E. J. Spratt described how Donald Smith missed his first swing with the sledge-hammer, bent the spike and had to call for another which he drove home successfully.

The biggest part of the job was done. From 1886 to 1903, Cambie was Pacific Division engineer for the C.P.R. Early in 1886, the company decided to extend the line from Port Moody, the Pacific terminus by statute, along the shores of Burrard Inlet to Coal Harbour. He supervised the building of this extension as well as the construction of the first wharves and terminals. He also superintended the replacement of wooden bridges with steel and masonry and of most of the grasshopper trestles with fills and retaining walls. The branch lines built to New Westminster in 1887 and to Nicola in 1906 were also his work. In 1903, he became consulting engineer for the company and continued in that capacity until his retirement in 1920. He had been at work for almost sixty-eight years.

"I've been working on the railroad
All the livelong day.
I've been working on the railroad
To pass the time away."

Whether or not he ever sang this ditty, Cambie had done more than pass the time away.

PERSONAL GLIMPSES

Though there may be no place in a factual report for personal glimpses and reminiscences, a biographical sketch confined solely to relevant fact might as well describe a machine. Cambie was a man. According to one of his surviving colleagues, T. E. Price, Life M.E.I.C. of Vancouver, Cambie was a "great and good engineer and MAN!"

He took an active part in community, church and professional affairs. A memorial tablet, erected by the congregation of Christ Church in Vancouver gives evidence of the work he did for the church. He became a member of the Canadian Society of Civil Engineers, later to become the Engineering Institute of Canada, in the second year of its existence, 1888. He served on its council for five separate years. Two of his papers were published in the *Transactions.*

His paper on "The Fraser River Bridge" appeared in the *Transactions* of 1891. The following excerpts from that paper may startle his colleagues of the 20th century, who may think that rush jobs were unknown before the turn of the century.

"The work was started rather hurriedly, only four days being taken to prepare a plan and specification, and contractors having only three days in which to tender, nevertheless the work has not been materially altered since its commencement."

"The chief difficulty lay in designing piers of moderate cost which would be safe in winter when there is thirty-five feet of water, a current of two and one-half miles an hour and at times ice which shoves with great force, and in summer when there is fifty-nine feet of water, a current of five miles an hour and driftwood coming in tangled masses, sometimes nearly an acre in area, as well as trees of great size."

His second paper on "An Unrecorded Property of Clay" appeared in the *Transactions* of 1902. This dealt with the loss of cohesive properties in thoroughly dried clay subsequently wetted again. The author recorded that it became "almost a liquid mud". Clay which had not been so dried would not absorb any more water and would lose "only some of its outside particles in the washing". The experiment used to demonstrate this property was a model of simplicity:

"When a block of this dry indurated clay was placed in a soup plate and water dropped upon it, the clay absorbed 50% of its own weight without any change of form or other visible effect, but when it had absorbed about 60% of water, its structure completely collapsed, and it became as fluid as water."

The results of the experiment were used as evidence in a lawsuit in which the C.P.R. was involved, dealing with the incidence of landslides in clay soils.

Some of Cambie's experiences, particularly during his work as an explorer and surveyor, are worth recounting briefly. They give some indication of his character and of his sense of humour. In the early days of the West, encounters with Indians were part of the surveyor's life. Some of the encounters were amusing, others were frightening.

About ten years before his surveys through the country of the Chilcotin Indians, a party headed by a Mr. Waddington had deeply offended the Indians. When they returned to their camp the following spring, the Indians one night waited until the camp was asleep and, dropping the tents on the sleeping men, stabbed sixteen men to death while they were tangled in the canvas. Only one survey party, armed and accompanied by a magistrate, had been through that part of the country since the massacre, and had seen little of these Indians. Cambie's experience with them is recounted in his "Reminiscences" which appeared in the October, 1920, issue of *The Engineering Journal*, in part as follows:

"Before making an actual survey, I went for a four or five days ride into the Pass, accompanied by Mr. M. Eberts, my assistant, and a couple of packers, a Frenchman and a Mexican. We took with us some blankets, clothes and tobacco as presents for the Indians if we should meet any. On our second day out from the main party, we found a band of thirty or forty Indians camped on a sandbar between a lake and a swamp and putting up (smoking) fish for the next winter. We offered them presents which they scorned, ordered us to turn back, and one man got up on a stump, gesticulated wildly and made a most impassioned speech. So we packed up our presents and proceeded on our way for another couple of days ride.

"On our return, about three days after, we passed over a mountain spur about two miles away from the Indian camp, and could see them on the sandbar, men, women and children at their various occupations. When we reached there, however, every soul had disappeared, even the horses and dogs—and though often there afterwards, I never discovered where they had gone.

"Our pack horses were running loose and I called to the packers to lead them by the halters, which they did, as the Indians were evidently very hostile and might stampede them. So we passed on quietly and had gone, say a couple of miles further, and were in a narrow defile between two hills and riding in single file, when I heard a noise behind and on looking back saw a dozen or more Indians coming full gallop on horseback, with very scant clothing but each one armed with a Hudson Bay Company's musket, having a barrel over three feet long and a knife or some other weapon in a belt—when they came close they opened out into two columns, one passing at each side of us, and when the last man came even with me they stopped dead, throwing their horses on their haunches. No one spoke—we kept on our way, a fast walk, and soon left them behind. I confess that, knowing these men to be of the same families who had murdered Waddington's party ten years before, it gave a cold chill down my spine, but I kept outwardly calm, knowing that any sign of weakness would be very bad.

"When we had travelled another mile or two, our friends repeated the operation, and when they pulled up next to me, one of the Indians opened a conversation in "chinook" and said they would accept the presents offered them five or six days before. This I absolutely refused to consent to, and stuck to it, notwithstanding sundry threats, but on the advice of a priest who came to visit them a few days later, consented to hand them over."

"Chinook" was the universal language of the day, consisting of approximately 200 assorted French, English, Spanish and Indian words. Cambie reported that he had had people speaking five different languages in survey parties of twenty or twenty-five and that the only way to communicate was by using Chinook.

He also recalled an excursion into the occult when he was asked by a group of Indians for a demonstration of Hell. This is how he reported it: "A number of the men came to my camp one Sunday, shortly after, and told me they had come from Mr. Jennings' camp, thirty miles away, to ask me if I believed in Hell, as it had been described to them by the priest and illustrated by Mr. Jennings. On being pressed for an accurate description it appeared Mr. Jennings had burnt something in a soup plate, which I afterwards found to be brandy, and as it was in a brilliant sun they could not see the flame, though its burning power was good. I backed up Jennings' description, and gave them a similar exhibition to their very great satisfaction."

Other reminiscences were reported in the articles published in *McLean's Magazine* in the winter of 1923-1924 under the title "Blazing Trails in B.C." written by Noel Robinson. Perhaps one of these should be recounted here, not because it was spectacular or amusing, but rather to indicate how Cambie felt when he thought he had been abandoned by his party, with winter fast approaching. The incident occurred during his survey of the Peace River, the Skeena Valley and the Pine River.

This is part of the story, as Cambie told it to the reporter:

"I arrived at Hudson's Hope as intended, but found that the spurs of the mountains reached out forty miles farther to the eastward, so attempted to go straight south by way of Moberly Lake. There I found a hunter named Armstrong with a good outfit of all that a hunter needs, and, as we had got into a country with a good deal of fallen timber, I induced him to come with me for some days and help to cut a trail to get the horses through. After three days' travel, in the course of which we had made, perhaps ten miles, we got into a cul de sac.

"So I got Armstrong to remain with me while I sent my two men forward on foot to find Pine River and the main body of my pack train. We were getting very nervous, as it was the end of September and winter was approaching rapidly; so after remaining two days and the men not returning I left Armstrong to watch my animals and climbed up some steep hills in front of me. When I reached the top of a ridge which blocked my way it turned out to be only fifty feet wide and dropped into a valley which was far below. I knew this must be Pine River, and as the men had been so long away, I feared that they had waited for me as long as they had thought judicious and had then deserted me. I determined to find out and started down the hill. When I got some distance down I thought I heard a bell such as packers put on their horses. But I was excited and out of breath and could hear nothing clearly but the beating of my heart. The same thing occurred several times before I reached the bottom and I began to wonder what was the matter with me. Finally as I got to the bottom of the hill, I felt confident again that I heard a bell. Suddenly I stopped in astonishment. There was the whole pack train of about forty horses in front of me! I gave one great war-whoop that would have wakened the dead.

"A few minutes before I had made up my mind that if the men had passed I would go back to Hudson's Hope, kill one of the animals, as I was almost out of food, make a raft and drift down to Dunvegan and make my way to Fort Garry by the Spring. But the risks of such a proceeding so late in the year, with a scarcity of food, would have been very great."

Other stories and anecdotes may be found in the original articles and in his "Reminiscences".

RECOGNITION AND HONOURS

After his retirement from the C.P.R. in 1920, his services were retained by the company in an advisory capacity. A station on the company's main line was renamed Cambie during his lifetime and a street in Vancouver was also named after him. The Vancouver Pioneers Association presented to him the Hudson's Bay Company medal, an award made to the pioneer most worthy of the honour. Perhaps the greatest tribute paid to Cambie was the respect and affection he received during the last years of his life. For it had been such that there was no need to let tempers cool or to allow time for injuries and hurts to heal before honouring him.

When he died on April 23, 1928. at the age of 91, he had earned and kept the respect and affection of those who knew him. Those who remember him still are proud to have known him, for he was "a great and good engineer and MAN!".

E.I.C. TABLET DEDICATED

This is the inscription appearing on the Engineering Institute plaque honouring Henry J. Cambie:

In recognition of the outstanding engineering achievements of Henry John Cambie, M.E.I.C., 1836-1928, whose surveys and explorations determined the location of the Canadian Pacific Railway through British Columbia and who supervised its construction through the Fraser River canyons, 1880-1884. Erected and dedicated by The Engineering Institute of Canada, June 1957.

Amplifying the Baccalaureate Education

A panel discussion held as Session 4 of the joint Conference of the American Society of Mechanical Engineers and the Engineering Institute of Canada, University of Western Ontario, October 1956

H G. Conn

Dean of Engineering, Queen's University, Moderator of the Session

You may all recall from your early school days that you had a burning desire to learn about things not taught in your engineering classes. Many of you longed for time to just sit and think. I have had students who claim they could become interested in almost any subject including Religion, Theology, Art, etc., if they were not so busy. Many of them deplored the fact that they did not have time to go to a few concerts, to read a really good book or to study an interesting biography.

All this hustle and bustle is caused by the pressure imposed on the student by our engineering educational system. As such, it is considered to be beyond the control of any one particular person and is accepted as inevitable. There are sufficient murmurings to indicate that there is something amiss.

When the student graduates he shakes off the shackles and finds that he can now do as he wishes. Never again will he open a book. He will go to work, do well at the job for which he has been so well prepared, quit at 5.00 p.m. and enjoy life. It may take a full year for this new graduate to realize that this type of life is very boring and soul-destroying. He wakes up some morning and realizes that he knows little more than he did a year ago except maybe where the first-aid room is and a little about the day-to-day operation of the plant.

It is at this phase of his development that the graduate engineer becomes conscious of the need to "Amplify his Baccalaureate Education".

I think that three distinct channels present themselves as offering opportunities for positive action in the solution to his problem.

(*a*) Further study of technical matters.

(*b*) The study of non-technical subjects associated with his work, e.g., economics, marketing, sales, personnel work, corporation finance, etc.

(*c*) The study of things not associated with his life as an engineer but designed to round him out, make him a more useful citizen and a better parent—in other words, pursue those fields of which he had fond dreams as a student but which were denied him due to the inevitable time element.

I hope that the Panel will cover some or all of these channels of endeavour.

Cornelius Wandmacher

Head, Dept. of Civil Engineering, University of Cincinnati

Perhaps the most distinctive characteristic of a professional man is his continuing interest in education as a medium of personal growth. But interest alone on the part of an individual is not automatic. Even when it exists, it is not in itself sufficient.

What then must we do to insure the necessary stimulus for amplifying the baccalaureate education? The following steps seem essential:

(1) To instill in the undergraduate a spirit of initiative and self-reliance.

(2) To provide for co-operative educational efforts between industry, education, and the profession in the community where the young graduate begins his career.

(3) To aid the young man to identify and define his educational objectives after graduation.

(4) To foster the concept of engineering as a dynamic profession.

Initiative and Self-Reliance

To be well prepared to "amplify" his baccalaureate education an individual must have had a suitable basic education. Therefore, it is essential for us to consider first what kind of an educational background will serve best in establishing the foundation and framework for later amplification.

Clearly the need is for an educational program which will stress the development of favourable attitudes as much as the immediate attention to subject matter details. The need is for a program which will instill in the student the spirit of initiative and of self-reliance in the educational process. It should be one which will help him see in professional accomplishment the "wholeness" of knowledge, experience, and continuing education.

It is appropriate to stop at this point and consider how this sentiment has been expressed over the years in various reports on engineering education.

As early as 1929 the Carnegie Foundation report pointed out that the most serious deficiency in engineering education was not so much in any subject matter omitted from the college program but rather in the custom of allowing the orderly process of education to stop, where it so often does, at graduation.

Experience in this survey led to the following conclusion concerning the marks of retarded professional development in young graduate engineers:

"Many are victims of a deficient education, not in the sense that college failed to teach them all that they would ever need to know, but rather failed to inculcate in them a taste and a capacity for continued learning under self-direction."

This was one of the first awakenings to the need for continued education on a broad basis beyond the bachelor's degree. Naturally there has been considerable progress in intervening years.

The Impact of Teaching Method

Unfortunately, discussions concerning engineering education more often than not center around the question of subject matter content of the curricula. Only infrequently is full attention given to the primary question of objectives. Even less frequently is due attention given to the most effective means of achieving these goals through appropriate teaching methods.

In 1950-52 the American Society for Engineering Education devoted its principal attention to this matter as a national project. The resultant ASEE Monograph on the Improvement of Engineering Teaching identified the following as one of the major challenges of teaching:

"How to instill in the student the desire to continue to learn after graduation and how to provide a cultural foundation which will encourage him to contribute to his local community as a mature, thinking, human individual."

Laying the Groundwork

In short, this report indicated that a primary task in undergraduate teaching is to lay the groundwork for amplifying the baccalaureate education. It is, therefore, not so much the question of *what* we teach, but more so the matter of *how* we teach, which in the long run will measure our success or failure in these formative years.

Again in the conclusions of the most recent report (1955) of the ASEE Committee on Evaluation of Engineering Education we find a reference to the need for amplifying the baccalaureate education. This statement broadened the base of educational responsibility over that in previous reports. It said:

"The entire educational process is more inclusive in scope than an undergraduate curriculum, for it also includes training in high school and post-baccalaureate study in a university or in industry, along with continual self study and with experience in engineering practice before full professional status can be achieved."

This is the first of such reports to point directly to the responsibility of the employer for education in the post-baccalaureate period.

At this time when faculties are faced with the problem of sharply modifying engineering curricula, they find themselves under pressure from many sides to include one or another subject in the undergraduate course of study.

Amplification — A Co-operative Effort

For this reason it is all the more important to re-emphasize that much desirable work in the way of subject matter fields must be deferred until after graduation. At the same time it is well to point out that the necessary "amplification" of the baccalaureate program is a joint responsibility of industry, the University, and the professional societies of the community in which the young graduate finds his first full-time job.

While each one of the triumvirate —industry, education, and the profession — may be carrying forward a substantial part of a professional development program, the results of a concerted effort integrating the work of all three will be of far greater significance than the results of three separate efforts. This fact has been well borne out by the recent community experiences in Cincinnati and Detroit with the "First Five Years" program of the Engineers' Council for Professional Development.

Professional societies through the medium of meetings and seminars make many important contributions in the task of amplifying the young engineer's educational background.

Identifying Objectives

A question frequently asked is: "What makes the day after graduation different from the day before commencement?"

The most striking difference, of course, is the need for identifying new objectives. While in college the striving for completion of a curriculum and the goal of a degree have given the young man a definite objective, the objective of a group. After graduation the objective must be more individual and more personalized.

Discussing the need for well-identified objectives, James B. Conant brought the matter clearly in focus when he said:

"They represent goals toward which men and women move by concerted action. They never can be reached in practice — almost by definition since they are ideals — but we can recognize whether we are moving toward them or retreating.

"Objectives are not merely goals; they are motivating forces for action; they furnish an incentive, a purpose, and help to chart a course."

Need for Sponsors

It is at this point that the young man must seek a new counsellor to aid him in identifying new objectives for his post-college development program. Personal associations through a "sponsor" plan as developed by many industries and by a number of professional societies can be of invaluable service to this end. With proper guidance in this period the young man may "find himself" more fully than ever before.

In his well-known paper The Second Mile" William Wickenden sounded an optimistic note on the manner of dealing with this problem and put his finger on several key points when he said:

"Much has happened in recent years to strengthen the belief that possibilities in the mile of voluntary advancement are more hopeful than any lengthened mile of compulsory discipline.

"What has been particularly noteworthy is that so many postgraduate students are pursuing interests and needs which they have discovered for themselves in their early professional experience rather than a further discipline, however ideal, which others had imposed upon them."

Engineering — A Dynamic Profession

Contrary to the notion in the minds of many young graduates, engineering science is far from the established, well-ordered, definitive state in which they might wish it to be. Today's answer and tomorrow's answer to the same problem may be quite different. Formulas, empiricisms, even laws and principles have a way of taking on new aspects with every passing day.

In his paper "Objectives of Professional Education" presented at an interprofessional conference, Harry S. Rogers, representing engineering, said:

"In scientific-technological thought conclusions are accepted tentatively. We speak of principles and laws as truth with full realization of the fact that they are conditioned by the present state of knowledge.

"We utilize principles we know to be inaccurate because they are currently the most useful tools available for the solution of practical problems. Knowledge is considered progressive and the current state approves and accepts, or corrects and amends the earlier."

The Hazard of Stagnation

One of the major factors frequently overlooked in the present critical shortage of engineering manpower is the number of engineering graduates who have been effectively lost to the profession. They have become lost because they have become inadequate in the light of recent scientific developments. They have become inadequate because they failed to amplify their baccalaureate education. They have failed to understand that unless we are constantly forging ahead we are in fact falling behind.

In summary we may conclude that for optimum professional growth there must be four supporting elements:

(*a*) An inculcated sense of individual initiative.

(*b*) Opportunity for group activities.

(*c*) Means of identifying personal objectives.

(*d*) The concept of a dynamic profession.

With such supporting elements the continuing education program of any professional group will become self-perpetuating.

Left to right: F. E. Verdin, Management Consultant, Cleveland, Ohio; C. Wandmacher, University of Cincinnati; H. G. Conn, Queen's University, Kingston (Moderator); R. E. Jamieson, McGill University, Montreal; Dr. B. B. Hillary, Research Co-ordinator, Dow Chemical of Canada, Limited, Sarnia.

B. B. Hillary

Research Co-ordinator, Dow Chemical of Canada, Limited

As one of the industrial representatives on the panel I will attempt to give some information as to what industry is doing to amplify the baccalaureate education and at the same time try not to infringe too far on the subject matter of the other panels.

The continuing education of the graduate can take the form of post graduate courses, evening courses, correspondence courses, or special courses such as executive development, all offered by universities. Along with this there are formal courses administered by industries themselves as well as various forms of in-plant training. I shall use as a case example one large American industry with a program that embraces most of these phases of education.

The case example selected is the educational program of the Dow Chemical Company, Midland, Michigan (this happens to be the parent company of Dow Chemical of Canada, Ltd.).

It provides an excellent example of a well balanced program and in some aspects it is unique, but the same conditions could apply to other companies in similar types of locations. Much of the program was made necessary because of the remote and rural situation of Midland, a town with a population of 20,000. In order to develop tradesmen and operators from such a limited labour pool special training courses were necessary. In the case of those wishing technical and liberal arts education it was not practical for them to go eighty miles to the nearest university for night classes. Midland's industries are predominantly chemical, with Dow Chemical having approximately 12,000 employees and Dow Corning 1,400 employees. As is characteristic of the chemical industry a large percentage of the employees are technical; scientists and engineers. All branches of engineering are represented with chemical and mechanical leading.

The Dow Educational Program comprises two main types of education: the Midland Public School adult education program, a co-operative effort of schools, universities and the company; and the in-plant training program for technical and non-technical employees.

To administer this program the company has a large and active educational department. This department is not set up for the sake of teaching, it is a service department. It will not duplicate anything a school or university can do. Its role in the adult education program is one of assistance and co-operation. It will find out what the employee wants and assist the Adult Education Advisory Council in making the arrangement with schools or colleges and, when necessary, give financial support.

Briefly, the Midland Public School adult education program is administered by a full time director who works closely with the extension agencies of the University of Michigan at Ann Arbor, Michigan State University at East Lansing, Central Michigan College at Bay City, the Midland Adult Education Advisory Council, and the Dow Education Department.

The program has no rigid organizational structure. Courses are added and dropped as dictated by student interest, availability of instructors, space and teaching materials. Courses cover a wide range of subjects from handicrafts to advanced chemical subjects. Cost of the program is borne by the students, who pay fees and materials cost, if any; the Midland School system; and Dow.

The program of courses is divided into four levels — graduate college, undergraduate college, post high school and high school, and correspondence at all levels.

Graduate college level courses are given by the University of Michigan and Michigan State University in technical areas pertaining to chemistry, physics, mathematics, engineering education, and business administration. Some courses are taught by Dow employees, experts in their own right and certified by the administering school. Credit is available for successful completion of such courses ultimately leading to advanced degrees from one of the two universities. In the case of some courses credit can be transferred to other institutions.

Arrangements have been made whereby if a student has taken the pre-requisite evening courses he can obtain a degree from the University of Michigan or Michigan State University by spending a minimum of eight weeks in residence at a summer course. He is expected to utilize his vacation period as part of this time and he receives full pay during his leave of absence. In the case of a student seeking a Ph.D. degree he is allowed one year's leave of absence with income and welfare benefits.

Undergraduate courses are given by the Universities and Central Michigan College. Here a much wider variety of courses, including liberal arts as well as technical courses, is available. Instructors usually come from the administering institutions. Successful completion of some courses gives the individual full college credit.

Post high school and high school subjects are the most popular in the program. Nearly 50 different courses are taught in this category.

Correspondence courses are an integral and important part of the adult education program both at the high school and college levels. In the case of high school courses the Midland High School provides teachers and classrooms and the correspondence school texts, lessons and examinations.

It should be emphasized that students on the adult education program spend fully as much effort and time for a given course as does a student normally enrolled in the administering institution. By law the number of class hours is the same.

In the past year approximately seventy-five different courses were taught in the adult education program and there were 2,039 courses completed. Or, 94 per cent of those starting courses at the beginning of the term completed them. This speaks highly of the ambition of the people and the quality of the courses.

Thus by means of this comprehensive Midland adult education program the engineer can broaden his education not only in technical fields but in vocational training and management development; communications fields, such as public speaking, foreign languages, psychology and personnel; crafts, music, literature and fine arts.

The other main part of the Dow Educational Program, in-plant education, covers maintenance training, powerhouse training, production training, supervisory development, and college graduate training. The approach is to develop special skills required by people to do their job. Here again the Education Department acts as a service department in that it helps line supervisors discharge their training duties, this in keeping with the basic policy of Dow management that training is the responsibility of line supervision.

Through the training available within the company, the graduate engineer can expand his knowledge of human relations and economics, so necessary for supervisory development. By means of the special assignment program, several six to eight week training assignments in various departments, where accomplishment is measurable and each project has a definite beginning and end, the graduate feels he is making a worthwhile contribution while he is becoming oriented within the organization.

Other than the brief mention of a few of the concepts of the Dow inplant educational program no details can be given as time does not allow and the subject matter gets beyond the scope of this particular panel.

Attitude of Canadian Industry

It was considered it would be interesting to have a picture of the practices and attitudes of Canadian industry in respect to the continuing education of the engineer. In order to get this a random selection was made of some thirty industries employing engineers. These represented a cross-section of automotive, chemical, electrical, metal, petroleum, pulp and paper manufacturers. The purpose of the conference was outlined and they were asked if they cared to report on their program for the continuing education of the engineer and what they thought should be done. Had they been presented with a check list of specific questions we would have had more detailed replies in a form that could be compared. However, it was not considered appropriate to ask companies for too much detail of their organization. The response was very gratifying and much interesting information was given. I will review it briefly.

As would be expected there was a definite correlation between the size of the company and the amount of educational activity it carried on. The number of companies in Canada employing large numbers of graduate engineers is limited, thus we do not have as many elaborate programs as we find in American companies. No two companies have the same type of program but some are similar in parts. Each is patterned to meet its own type of manufacture, location, and management philosophy.

Most of the reporting companies have no formal organized plan for the continuing education of the graduate. A few have well developed programs and some are close to having a plan in operation or are contemplating it.

In the field of graduate studies a few companies reported they encourage employees who are interested in continuing their education. In some cases financial assistance is given. This included payment of tuition in full or part and where leave of absence was necessary and salary was not paid employee welfare benefits were maintained.

Evening and correspondence courses were recognized by numerous companies as a means by which the individual could improve himself. Where the initiative came from the individual some provided financial assistance ranging from 50 per cent to 100 per cent of the fees. Here, strong emphasis is placed on cultural courses or courses improving the overall knowledge of the employee in addition to purely technical courses.

Most companies send personnel to executive development courses. In some cases this was confined to senior men and in others it included junior executive talent. Types of courses and institutions selected covered a wide range. Some companies are now stressing management development courses that emphasize cultural as well as business training.

Most companies had some form of in-company training program. These range from special training courses run by consultants, to company-operated courses taken by all new graduates as part of their indoctrination into the company. Others have a system of job rotation for the first 12 to 18 months. Some multi-plant companies have found that transfers from plant to plant provide an excellent means of adding to a man's education. Some keep elaborate records of performance on the job, courses taken and other means of employee improvement to determine future promotion. These records are also used to determine what courses are required by the individual for his future advancement.

Most companies support active participation in technical organizations and attendance at meetings to broaden the individual's background. Likewise civic and community committee activities are encouraged.

Some companies hire an engineering graduate because he has the specific educational background for a particular job. Such people are ready to start to work with little or no additional training and as long as they are in design or operational work they are adequately equipped technically to carry out all assignments. If any of these people are of potential management calibre they do need further education along the lines of human relations and management training and are given the opportunity to acquire this.

Several companies state that they consider the undergraduate technical training of the engineer adequate but feel that more emphasis should be put on liberal arts education. They would like to see him get more of a grounding in the humanities and economics in his undergraduate years. Though it is true that during his first few years of employment he draws exclusively on his technical training, he should have some background of ethics or a framework of philosophy upon which to reorganize and develop the economic, political and social relationships which he must have to carry out his job effectively as a supervisor or manager.

From the foregoing it can be seen that the industries sampled expressed widely varying viewpoints on the subject of the continuing education of the engineer. While no definite conclusions can be drawn one thing stands out prominently. Many industries expect to draw, to a large extent, their future management personnel from engineers. They recognize these men must get additional liberal arts and business education to supplement their predominantly technical training. They are concerned with, when, where and how these men can get the necessary education and for this they look logically to the educational institutions.

R. E. Jamieson

Dean of the Faculty of Engineering, McGill University

The needs of the graduate engineer for post-baccalaureate study have been emphasized in much of the previous discussion during this present conference and are, I believe, well recognized by the individual. For the individual it becomes largely a question of the availability of formal courses and of his opportunity to participate. Generally there is no problem when one lives within easy distance of an engineering school. Most schools provide courses in the evening, usually in an extension department. These courses include some which are at the post-graduate level and which in many cases can be used to form part of the training for a master's or higher degree. Others are purely of the extension type and are not acceptable toward degree work.

The people who undertake these courses fall into three broad groups. There are those who are primarily interested in further training, whether in their own field or in new work, and who are not seeking recognition for their work in the form of a certificate or diploma. Then there are those who, while interested in the further training, are also eager for academic recognition in the form of a post-graduate degree. And between these two goups are those whose circumstances permit them to take formal courses in their own fields and at the post-graduate level, but who cannot meet the residence or thesis requirements of the school concerned. I think I can perhaps discuss the problem best by referring to the conditions as I know them at my own school, McGill University, as I believe that our conditions are fairly typical for Canada.

For the first group mentioned, namely, those who are not greatly concerned about receiving academic recognition, there is no problem for the man who can attend at the university during the evenings. He may select any courses he desires, and there are no prerequisite academic qualifications which he must meet. A very large and varied group of courses is available to him.

For the people who wish to do something toward a post-graduate degree by way of evening study, the requirements for admission to such study must first be met. That is, these students must submit academic credentials and secure acceptance by the Faculty of Graduate Studies and Research. All schools have some form of residence requirement, which means, in effect, that the candidate must live within the atmosphere of the university for a period if he is to qualify for that university's degree. In addition, Canadian schools demand a thesis based on independent and original work by the candidate, and in the case of engineering students, this usually involves some experimental work in the laboratories. These requirements cannot be met by evening work alone and therefore constitute a stumbling-block. I might add that the thesis and experimental work are requirements in Canada both at the master's level and at the doctorate level.

McGill has recently made some special arrangements for people of the second group who are able to take the formal course work in the evenings but whose circumstances do not permit the meeting of the residence requirement or thesis. We have recognized that men who complete successfully a group of formal courses which would normally satisfy this segment of the requirements for the master's degree, should have something to show for it. It should be noted that such men are fully qualified for post-graduate study in the field of their choice. Our Senate has authorized the award to such people of a certificate of performance covering their work. We feel that while this certificate is perhaps in danger of being confused with the actual diploma of the master's degree, it is only right that these men should have something of an official nature to show their degree of attainment. For example, we have instituted such a certificate for award after completion of a group of post-graduate courses in aeronautical subjects.

In the nature of things, educational institutions are the most natural agency for giving the formal course work at the post-baccalaureate level, and we are very happy to do it. Our policy at McGill is to put on any course for which there appears to be a real demand, and our only stipulation is that the number of registrants shall be at least sufficient to make the course self-supporting. At the present time we have evening courses at the graduate level in the general fields of electronics and of aeronautics. The former includes some thirteen separate courses and the latter some nine courses. The requirements toward the master's degree would include a selection from one or other of these groups. Situated as we are in a large and highly industrial community, it is natural that we find no difficulty in attracting sufficient registrants to justify the programme.

In addition to formal courses of instruction, the facilities provided by engineering societies through professional meetings, papers, and discussions, are important agencies in post-baccalaureate training. Since local branches of the societies are much more numerous and widely dispersed than are our engineering schools, the numbers who can use their facilities are consequently much greater. And because formal courses are probably the most efficient means of effective training, it might be possible for local branches to expand their educational efforts along that line. This would at least serve the group who do not especially desire academic recognition.

However, neither universities nor local branches can be of much help to the man who is not living close enough to the centre to be able to participate. I am afraid that I have no ideas to offer as to what may be done for such a person in furthering his post-baccalaureate training by formal courses. So far as I can see he will be thrown on his own resources. Perhaps some suggestions along this line may be forthcoming from the discussions at this conference.

Florent E. Verdin

Management Consultant,
Cleveland, Ohio

It has been my privilege to look at our subject from a number of different viewpoints. While in industry's personnel field, I encountered the problem of how to broaden employees with engineering education and experience, so that they might accept the responsibilities associated with supervisory and administrative positions. Along with that problem comes that of appraising the potential of technical employees, and charting a possible course for their development — including education and training in areas not necessarily touched upon in their undergraduate days.

The opportunity has come to me to see this problem through the eyes of the educational institution, through participation in the original planning of two courses, of the management development character, in two U.S. universities. One was the University of Michigan, and the other Case Institute of Technology.

And, a touch of the "firing line" has come to me through participation as a speaker or moderator in university courses of this nature and in various activities of organizations such as the American Management Association.

As a result of these experiences, plus consultations with clients on this matter, it is my conclusion that industry and educational institutions must get ever closer together in their joint approach to building better managers. This is not to imply that much good has not already been done, nor that industry and education are blind to each other's points of view.

However, this problem of amplifying the education of the engineering Bachelor of Science can be likened to that of a purchasing agent in determining what to buy. He first determines the needs, measures stock on hand, and goes out to acquire the difference. The key to the whole matter is in determining the need.

If we can determine the need for additional education and training and agree upon what the objectives are we can provide the means to achieve such goals.

There are three parties to this endeavour: the man himself, his employer in industry, and the educational institution from which he may seek help or to which he may be sent by his employer for further training.

The Individual

Unfortunately, today's competition for the young engineering graduates has created an illusion in the minds of many young engineers. The fantastic starting salaries and employment conditions have developed a picture of a land of milk and honey. I do not say that these young men are in the slighest way to blame for the condition, but it places a handicap upon their future growth. Partly as a result, too many lack the ambition to extend themselves to the full extent of their abilities. Too many refuse to accept the compromise between pure science and economic practicability. Too many become disgruntled upon finding, after the honeymoon, that the economic road for strictly technical personnel has many rough spots.

Then these individuals have the problem of adjustment. Their background of education has emphasized the "engineering approach". This implies the use of a specific set of mental and physical tools to each specific problem and tends to exclude any other approach. In fact, it tends to create a line of exclusive thinking on their part which sets them apart from other trades and professions upon which they look with amused forebearance, to say the least.

This sort of thinking leads the engineer to "stick to his last", to specialize, to ignore other facets of a going business and even to create social strata bound by the lines of the engineering degree. Thus he works to his own disadvantage because the one thing he needs is breadth of viewpoint, experience, knowledge and human relations.

Company Management

As to industry itself, we can draw a long list of possible criticisms. Let's take three important ones.

First, with respect to the shortage of technical and scientific employees, some of it is created by industry itself. Too many technically trained people are assigned to non-technical work. Much of the duty assigned, particularly to young engineers, can be performed by technicians and clerical, stenographic, accounting or secretarial personnel. We must recognize, of course, that part of on-the-job training for the young engineer requires his participating in many of these non-technical tasks to learn the business. However, it is my opinion that not enough technical work is assigned to these young engineers and that not over a tenth of the engineering graduates in industry are loaded anywhere near their mental capacity during their first five years in industry.

This indictment may fall not upon top management but upon engineers who are managing squads, sections or departments of engineers, such as some of you at this meeting. Many managing engineers are slow to trust important assignments to the youngsters until they've had several years of so called "apprenticeship" just because that's the way it was in the "good old days".

Second, let's look at industry's approach to management development courses, a field where much fine progress is being made. A great many companies — like their executives at the 19th hole — talk a great game. They are keeping up with the Joneses; they are sending executives to Harvard; they are up on the A.M.A. reports; they have intra-company programs; they're offering fancy salaries to young engineering graduates through a high-pressure recruiting operation.

But, I suggest, why do they do these things and how much good comes out of them? Perhaps a lot!

However, the mistake of doing these things *only* because they are popular business techniques, propounded by high-priests of business management can be pretty costly. Much more effective are the specific procedures upon which I have cast aspersions, if they are the result of long range planning to meet certain predetermined needs.

Third, many companies have handled the matter of salary progress in a manner which appears to be unwise, among these technical groups. It is the employer of technical and scientific personnel who has bid up the starting rate for young graduates to levels which are somewhat startling. These levels in many instances are equal to — and, I fear, in some instances above — the present salaries of similar personnel with five, or even more, years of service. Can any employer permit such conditions to exist and expect the morale and performance of the group to be up to par?

The Colleges

And now, to suggest a few questions for the educators.

First, are they preparing these young people to expect that their first few years in industry will be the equivalent of post-graduate training? It is then when they learn the *application* of the principles learned in college. It is then when they see the light of considerations such as cost, marketability and a host of other economic questions. It is then when they "unlearn" the application of "pure" scientific approaches to every problem. It is then when they realize that many economic answers are indefinite and decisions must be based on factors which are not exclusively engineering economics.

Second, are our colleges giving due significance to the need for breadth of knowledge among technically trained students? To assume places in the field of industry which their native talents warrant, engineers must have a broader appreciation, understanding and knowledge of the humanities, arts and social sciences, which were neglected in my day. Several of our institutions are making noteworthy progress in this direction.

Third, do our educators know enough about the educational requirements of industry? Some educators are so steeped in the "pure" sciences that they fail to recognize the practical problems of applying those sciences. Some engineering educators encourage students to isolate themselves from sales, social sciences, public relations, finance, personnel and other aspects of business which the growing engineer must comprehend if he achieves his full intellectual potential. Some educators think "more of the same at a higher level" when planning courses of executive development for use of industry, rather than ascertaining the needs of the prospective advanced management students and meeting those needs. Some educators have never looked at the inside of industry.

Moving Forward

And now if I have not alienated all of you — as individuals, managers or educators — by listing certain shortcomings and criticisms, let us look at a few recommendations through which I believe we can move forward to improved development of the talents of our technical and scientific personnel.

(1) Industry can take definite steps to reduce the shortage of engineers by eliminating much of the waste of engineering talent.

(2) Industry can correct the distortions in the compensation of engineers which has resulted from the rapid lifting of the starting levels without sufficient commensurate modification at other levels.

(3) Industry can adjust on-the-job training in the early years to give greater emphasis to the business relationships which engineers must learn, thus stimulating their efforts in the non-technical areas of learning.

(4) Industry must spot-light its needs for advanced education by: (*a*) Long range determination of managerial needs. (*b*) Inventory and appraisal of potential candidates for greater responsibilities. (*c*) Planning specific courses of action to meet the needs indicated by the inventory and appraisal. (*d*) Conferring with educators to apprise them of those needs which can be met by educational institutions.

(5) Educators must strive to give engineering students a better concept of the areas of knowledge which will be encountered in business and community life. To the extent time permits they should include courses of basic understandings of these areas in their curricula.

(6) Educators also must pattern their post-graduate activities to meet the needs of individuals in industry as well as the purely academic needs as they see them.

(7) Colleges and universities should take a close critical look at what is now being done in the field of management training. They should ask themselves: (*a*) Are the courses practical? (*b*) Do they provide growth in personal stature as well as intellectual improvement? (*c*) Are the leaders adequate to the job? (*d*) Is the whole undertaking tuned to the needs or particular characteristics of the area served? (*e*) Are they aiming at attracting youthful executives or attempting to retread old-timers?

(8) Industry and education must co-operate more fully and effectively. Seminars initiated by either group to explore each other's and mutual problems can make a forceful contribution toward better education.

These are certainly not all of the constructive steps which can be taken. They are steps which have come within my own experience and observation and which are effective.

The fact that every member of this group should have an interest in any better methods or techniques of "Amplifying the Baccalaureate Education" was well stated by Lawrence Appley, president of the American Management Association.

"International, national and local affairs have such a profound bearing upon the management job today that we must keep ourselves constantly aware of the world in which we live and alert to significant new developments."

Summary

H. G. Conn

As a result of the discussion here, I think it is agreed that the baccalaureate degree needs amplification. It was pointed out that this is merely another phase in the education of the engineer and is a very important phase. As stated before (Session 3) the onus of producing a good curriculum for this phase of study has now shifted from the teacher to the student and this may explain why many do nothing in the way of self-improvement after graduation. Mr. Verdin pointed out that many facilities exist for furthering one's education after graduation and each facility had its advantages and disadvantages, its strong and weak points. However, the assessment of these facilities is again up to the student. We can all help when help is asked for and can give the normal common-sense advice which it is the responsibility of all senior engineers to pass on as diplomatically as possible to their juniors.

DISCUSSION

of Technical Papers and Other Articles

LATERAL RIGIDITY OF STEEL BUILDING FRAMES

J. L. de Stein, M.E.I.C. and J. O. McCutcheon, M.E.I.C.

The Engineering Journal, 1956, October, 1343.

D. T. Wright,* JR.E.I.C.

The main implication of the authors' paper, that more or less typical single-storey building frames have inadequate lateral rigidity (which may lead to deformations of several inches under design loads), deserves some further comment. The authors have done a most useful service in applying the results of researches on structural connections to the often-neglected problem of structural rigidity. From the results of their computations it would appear necessary to increase the lateral rigidity of frames to guard against excessive lateral deformation. Although the validity of the computations is unquestioned, their practical significance should be examined in the light of what other knowledge can be brought to bear on the subject.

Such large deformations, as calculated by the authors, are practically unheard of in actual structures. It does not seem reasonable to attribute this only to the infrequent occurrence of wind loads of a magnitude approaching design levels. Deformations of 5 to 10 inches would be most apparent if they *ever* occurred. Instead it would seem that the actual rigidity of building frames must be larger than provided by the raw skeleton. Recent work[1] at the Building Research Station in England has been directed at this problem as it affects multi-storey frames (where lateral deformations would be very great if only the steel frame were effective). More applicable, here, are the results of tests performed by J. H. Percy[2] to determine the actual rigidity of a single storey pitched roof frame (which had been designed by plastic theory). He found that when one bay only was loaded (in a long building) deformations were only one-third as great as those calculated, and that even in a very long building loaded uniformly along its entire length deformations would never be as great as those calculated. These results are due, of course, to the effect of the wall and roof cladding, secondary members, bracing, etc. The building tested had only very light cladding, and with 32-ft. columns, with slightly over half the wall devoted to continuous glazing, could hardly be considered as very rigid.

One must conclude then that even with very light cladding, stiffness is greatly increased, and that a locally loaded area is able to share its load. Since wind gusts are very local in nature,[3] it is most improbable that a long building could be loaded over more than a small fraction of its length. Accordingly deformations would be significantly smaller than computed. For short buildings, where the entire wall might be loaded, the effect of the end walls provides similar restraints.

This then, seems to be another of those cases in structural engineering where calculations based on the customary assumptions (here, that only the bare frame contributes to rigidity) do not reveal what actually happens to real structures. Relatively little is known about the actual deformations of structures in service. It would be unreasonable, however, to become excited about large calculated deformations before real deformations of the same order had been experienced.

In their conclusions, the authors suggest that because of the large flexibility indicated in single-storey frames of conventional design "it is apparent that a plastic analysis has little practical application for these single-storey frames", inasmuch as plastic designs invariably lead to much lighter sections than are ordinarily used. In fact, plastic design has been used more for single-storey frames than for any other building type. It should be emphasized that plastic theory is concerned only with strength. The significance of plastic theory is that it is a rational method; whereas elastic theory predicts stresses which do not agree with experimental deviations,[4] plastic theory predicts load capacities which agree very well with test results. In designing on plastic theory, it is possible then to produce structures with known factors of safety against collapse. Deformations (under working loads) must be considered independently. The work by Mr. Percy,[2] which was described above, indicates that in real buildings deformations are much less than would be computed by usual methods. Further research on this problem being carried out by Mr. Percy at Cambridge University is expected to lead to means of estimating the actual deformation of buildings designed by plastic methods. In the meantime, over 100 single storey frames designed on plastic theory have been constructed in England.

*Queen's University, Kingston, Ont.

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(3) "Wind Loads on Structures", M. R. Horne, British Welding Research Association Report, July (1948).

(4) "Shortcomings of Structural Analysis", J. F. Baker, **Transactions**, North East Coast Institution of Engineers and Shipbuilders, v.68, p.31, (1951).

THE ECONOMIC POSITION OF CANADIAN SCIENTISTS AND ENGINEERS

John F. Haberer, and F. L. McKim

The Engineering Journal, 1956, October, 1366.

(This subject, as it concerns the United States, is dealt with on p. 820)

Dan N. Hendricks, Jr.[1]

I would like to make a comment on the article "The Economic Position of Canadian Scientists and Engineers" by Haberer and McKim in your October, 1956, issue. I think that it might be useful to draw attention to an erroneous assumption made by the authors even though this assumption played only a very minor part in their article. This concerns the plots of salary *v.* years since graduation (or age) for Canada, the United Kingdom and the United States. In discussing these curves, the authors noted that the slopes of these curves represented slightly different rates of advancement. To make such a statement requires the assumption that these curves are actually salary *growth* curves. Actually, they are simply plots of salaries of a group of people relative one to the other at one point in time (we call these salary *structure* curves). If the salary administration policies are in equilibrium, i.e., not changing from year to year, then the salary structure curve can be used to predict salary growth (if inflation is ignored or accounted for).

Now it happens that we have had an opportunity to conduct some statistical studies on the actual growth rates of particular groups of engineers. Even when these growth rates are corrected for the changing salaries paid new engineers, we have discovered that the average growth rate is substantially greater than that predicted by the slope of the salary structure curve.

For many years, we also made the assumption that the authors have made in this article. We have since learned that this assumption is so much in error that it leads to many conclusions which are very seriously in error. Anyone who is concerned with trends in engineers' salaries simply must resist the temptation to use a salary structure curve as if it was a salary growth curve. Otherwise, I do not believe he will ever come to an accurate understanding of the true circumstances.

[1]President, Seattle Professional Engineering Employees Association

[2]Chief, Personnel Services, National Research Council, Ottawa

[2]F. L. W. McKim

The points raised by Mr. Hendricks in connection with the comparison made in the paper of the slopes of what he calls the "salary *structure* curves" are interesting and well taken.

The slope of these "*salary structure* curves" are in practice, I agree, never equal to the actual average rates of advancement for any particular group of graduates. Accordingly, the wording in the paper in the third paragraph of the section headed "Salary Treatment by Type of Employment" was poor. Here we compared the slopes of the "salary *structure* curves" in Canada, the United States, and the United Kingdom and erroneously designated these slopes as "rates of advancement". As I see it, the slope of the "salary *structure* curve" is actually the *increase in average salary per additional years experience,* at one point in time. On the other hand, would it not perhaps be true that in general where the slope of the "salary *structure* curve" is steeper, there the actual rate of advancement for any group of graduates would be higher than for a corresponding group of graduates in an organization or country where the slope was smaller.

I was interested in the use of the term "salary *structure* curve" for the "plots of average salaries by year of graduation at one point in time. I would have thought that this wording might better be reserved for charts or graphs which would show the *number of persons at various salary levels within a group,* the salaries of which are being examined. A suitable term might be "salary experience curve".

I very much appreciated Mr. Hendricks' offer to send us copies of past material his Association has published in the field of salary studies. We do have a continuing interest in this field and would appreciate receiving such material as well as results of future studies.

REFLECTED RIPPLES IN THE RIDEAU CANAL

(Abstracts)

The Engineering Journal, 1956, January, 36.

D. C. Fisher[3]

The following is my explanation of the "Ripple Angles": It is evident the boat has not followed a true course through the canal. From the wake, I judge it is a twin screw.

If the boat is not at exactly dead centre of the canal, the change in direction of the water caused by passage of the boat, together with the fact that the rudder may be a degree or so to starboard or to port, causes this flow or current to strike one side of the canal before the other.

The first current to strike changes direction and angles back, and will therefore travel farther towards the opposite side before the two meet again. This process is repeated until such forces are overcome by the natural current.

[3]Project Superintendent, Defence Construction (1951) Limited, MacDonald, Man.

DISCUSSION

The editor invites discussion of papers appearing in the *Journal.*

Readers may contribute to this section by sending appropriate comments to the *Journal* office.

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

PAPERS OF THE INSTITUTION OF ELECTRICAL ENGINEERS

Convention on Ferrites

A convention on ferrites was held, 29 Oct. - 2 Nov. 1956, in London, together with an extensive exhibition to illustrate the subject. Some fifty-eight papers or presentations were made at the technical sessions, which included the following subjects: chemical and physical properties and preparation; magnetic spectra; molecular interaction; D.C. and L.F. properties; radio and television applications; new materials; square-loop materials; square-loop applications; microwave theory and measurements; microwave measurements and properties; microwave apparatus; and carrier frequency applications. The complete proceedings of the convention, including discussion, is to be published in a supplement to Part B of the *Proceedings* of the Institution of Electrical Engineers.

The BBC sound broadcasting service on very-high frequencies. E. W. Hayes and H. Page. (No. 3220).

The paper describes the developments leading to the inauguration of the BBC very-high-frequency service of sound broadcasting, which works in the band 87.5-100 Mc/s. The need for a very-high-frequency service is explained, and the considerations leading to the choice of frequency modulation rather than amplitude modulation, and of the national planning standards, are summarized.

In July 1954 the Postmaster-General authorized the first stage of the development plan, comprising nine stations. Later it was agreed that another station should be included in this stage, which is now virtually complete. In July 1956 the BBC was given authority to build a further six stations, which will be in service early in 1958. These sixteen stations will cover 95% of the population of Gt. Britain and Northern Ireland with three programmes. At a later date the BBC plans to build additional stations to extend the population coverage to about 98%. At the majority of the stations three programmes are radiated from a common aerial; special precautions are taken to minimize the generation of intermodulation terms.

The experience gained during the first year's service is described, with special reference to the performance of commercial receivers. The present stage of development of very-high-frequency sound-broadcasting services abroad is briefly summarized.

Frequency modulated V.H.F. transmitter technique (with particular reference to the British Broadcasting Corporation United Kingdom broadcasting network). A. C. Beck, F. T. Norbury, and J. L. Storr-Best. (No. 3235).

Equipment and performance requirements for frequency modulated broadcasting transmission are given, with particular reference to the British Broadcasting Corporation's recently introduced network of V.H.F. transmitters.

The general planning and design of the complete transmitting equipment used at the new high power V.H.F. sites is surveyed, including problems of unattended operation, automatic phasing of paralleled amplifiers and three-programme common antenna working, to indicate the progress made in this new field of broadcasting.

The design features of a current 10 kw. FM., transmitter operating in Band II (87.5-100 mc/s.) are described with special mention of the method of generating the frequency modulated carrier, its automatic centre frequency control and means for automatic phasing of the high power amplifiers operated in parallel. Details are given of a newly introduced system of transmitter control designed to increase the service reliability, thus reducing the demands on the time of visiting maintenance personnel.

Reference is made to the B.B.C.'s requirement of combining three independent F.M. carriers of 10 kw. spaced 2.2 Mc/s. in frequency to feed one half of a wideband horizontally polarized antenna, the other half being fed with an identical set of transmitters kept in phase within a few degrees. The necessary filter circuits, giving sensibly zero coupling between transmitters and negligible cross-talk, are described. Overall performance figures are quoted.

Cathodic protection. L. B. Hobgen, K. A. Spencer and P. W. Heselgrave. (No. 3285).

The paper deals with the theory and practice of the method of corrosion mitigation known as cathodic protection. The nature of electro-chemical corrosion and the fundamentals of cathodic protection are briefly discussed. Then follows a survey of the two practical methods of achieving cathodic protection — sacrificial anodes and power impressed currents. Since the method of measuring potentials is not that of normal electrical practice, this subject is considered in some detail together with the method of measuring soil resistivity. The possibility of adversely affecting other buried services is noted, and current practice in carrying out potential tests with the owners of such services, and of bonding to eliminate adverse effects is considered. Finally the application of cathodic protection and the general economics affecting its use are discussed.

DEFENDING BRITAIN BY ROBOT

Society of British Aircraft Constructors, *News Letter A. 1913*

Recent Government announcements have indicated that the role of the defensive manned fighter will soon be partially taken over by guided weapons and bombers will be superseded by medium or long-range rockets (intercontinental ballistic missiles).

Defence against manned bombers flying at 50,000 - 60,000 ft. at more than 600 m.p.h. carrying nuclear bombs must be made as near 100% effective as possible.

Work on guided weapons in Great Britain to counter this threat was initiated after the last war, but their development was influenced by the Staff assessment that there was little chance of major conflict before 1957.

The British guided weapon programme is co-ordinated by the Ministry of Supply. The English Electric — Marconi Wireless Telegraph — Napier group is working on a ground-launched anti-aircraft missile, Bristol and Ferranti on a ramjet-powered ground-to-air device, Armstrong Whitworth and General Electric are collaborating on a ship-to-air missile for the Navy, and de Havilland Propellers are evolving an air-to-air weapon.* In addition, Fairey has already produced the *Fireflash* for use by the R.A.F. as a training weapon, and a large number of other companies is engaged on power-plant, radar and guidance systems.

These weapons are "geared" to the radar-chain which encircles the British Isles. The American radar system is different, and it is, therefore, unlikely that a large-scale adoption of U.S. guided weapons is imminent, as has been suggested in some quarters. The cost of adapting either the defensive radar system or each American weapon purchased would be prohibitive and it is logical to suppose that British guided weapons may be operational fairly soon.

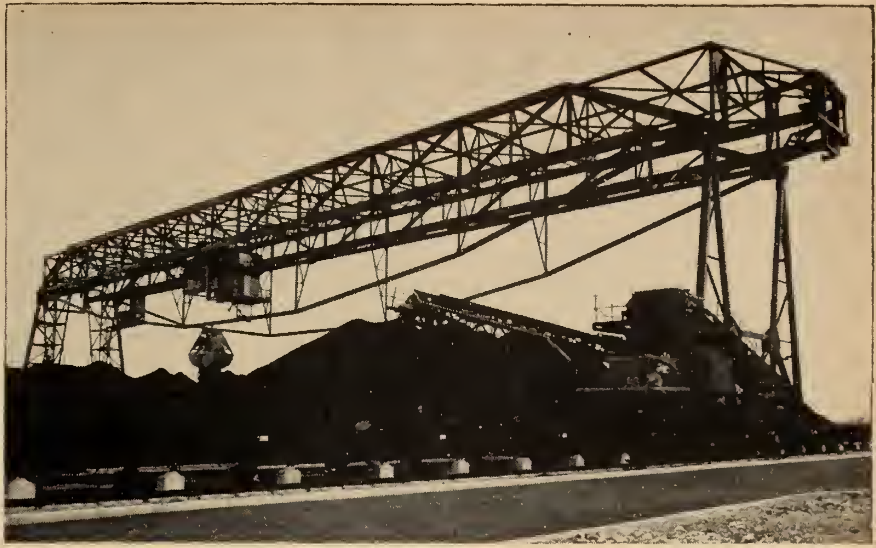
It is possible that one or two American interim weapons — such as *Nike Hercules* or *Talos* — not dependent on a radar chain for guidance, may be suitable as a stop-gap measure. (Once released, these "beam-riders" fly along a thin radar beam emitted by the ground station on to the target.) But it is unthinkable that effort and expenditure on guided weapons in Britain should be abandoned.

What of the long-range rocket or ICBM? The industry is developing these, but their effective operational use (in any country), is still some years distant. The main problem is their accurate guidance.

What defence measures can be expected to counter these missiles, equipped with nuclear warheads? There is no known answer at present. Assuming the ICBM descended at 10,000 - 15,000 m.p.h. or 3-5 miles a second, there would be little or no time for defensive action.

The best answer may lie in a stock of long range rockets kept constantly ready. The evolution of the ICBM is therefore of paramount importance. The greater part of the British aircraft industry — more than 400 companies — is engaged on guided weapon work of one sort of another. This work includes the sinister ICBM.

*It has been announced by the company that this weapon, the *Firestreak*, which incorporates infra-red homing, has been ordered by the Royal Air Force and will be fitted to the English Electric P. 1. and the Gloster Javelin aircraft.



LARGE TRAVELLING COAL TRANSPORTER

The largest travelling transporter in Britain is in service at the Central Electricity Authority's new power station at Tilbury. The transporter, designed and built by Mitchell Engineering Ltd., London, can spread and reclaim coal from the store at 800 tons an hour. Normal storage capacity is about 165,000 tons. The transporter bridge travels on tracks, 275 ft. apart, at 32.5 ft./min. A man-operated carriage, with a 9-ton grab, has a cross speed of 700 ft./min. and hoisting speed of 150 ft./min. The transporter bridge is of bow-string construction, supported by one fixed leg and a hinged leg at the other end to deal with track irregularities and to provide for expansion; each leg is mounted on four two-wheel bogies for travelling. Two bogies on each leg are motor-driven, and alignment gear is provided to ensure equal travel at either end of the bridge. Main current supply is through a specially-designed cable reeling drum with three flexible multi-core cables connected in parallel. The travelling carriage is made of rolled steel sections, braced and riveted to form a frame to accommodate the mechanical units. The grab is of the four-rope type and the hoisting winch is mounted on the travelling carriage. *(U.K. Information Service, Engineering Notes No. 52 (Ed., E. Mayson)).*

LARGEST MECHANICAL ORE-DRESSING INSTALLATION

Bureau de Presse Suédo-International, Stockholm, February 1957

A giant ore-preparation plant for the Kiruna mines, in the Swedish Arctic, under construction since 1954, has recently been put into service. When completed, at a cost of some $10-million, the plant will be the largest of its kind in the world, with eight pairs of magnetic separators each having a capacity of 500 tons an hour.

The plant will be officially inaugurated on 1st October 1957, when the iron ore workings in this district are transferred to the nationalized organization LKAB.

Open-cast mining at Kiruna has

been carried out since the end of the nineteenth century, but will finish in 1960 when conversion to underground mining will be complete. The new plant, 11 stories (170 ft.) high and some 380 ft. long by 95 ft., is one of the main facilities built for the new development. Output from these high-grade iron ore deposits (the largest in Europe and perhaps in the world) is to be raised from 10 million tons in 1956 to between 15 million and 20 million tons a year by improved extraction methods and without increasing the labour force.

The new plant has a capacity of 4600 tons an hour, corresponding to an annual capacity of 13 million tons. Each of the eight pairs of separators, mentioned above, is fed by six underground crushing stations in which blocks of ore weighing up to 10 or 12 tons are reduced to about four-inch pieces. The crushers will eventually be doubled.

Hoppers containing 20 tons are raised from the crushing stations at a speed of 36 ft./sec. to the dressing plant, where they are discharged into a system of screens and conveyors leading to the magnetic separator installations. Five different grades are produced, from 68% iron, 0.03% (max.) phosphorus, to 60% iron and over 0.8% phosphorus.

The graded ore is passed to one of twelve 8000-ton underground storage chambers connected to two railway tunnels which lead to the main Kiruna railway. Ore is discharged by gravity into 35- to 42-ton trucks; one load is completed in 30 seconds. Ore-trains go to Lulea, over 180 miles away on the Gulf of Bothnia, or to the Atlantic port of Narvik, at which a large installation was completed in 1956 to hold 3,500,000 tons of graded ore which can be loaded into ore-carriers at 4000 tons an hour.

The construction of the Kiruna plant presented several special problems, particularly because of the severe climatic conditions. Winter temperatures frequently fall to the range -20 deg. F. to -40 deg. F., but the building is well insulated and is heated throughout by the unusual means of using the heat generated by the electrical equipment that operates the separators. The main concrete structure was poured in two stages, using a sliding form no less than 720 feet long; over this is a layer of plasticized glass fibre about four inches thick, in turn covered by corrugated aluminum sheet (about 0.04 in.).

THE WORLD'S LARGEST LADLE CRANE

Seen here is the partly assembled bridge of what is described as the world's largest ladle crane. One of three being made by Morgan Engineering Company, Alliance, Ohio, for the steel industry, the capacity of the crane is 500 tons. Without the ladle, the crane weighs 1,841,000 lb. Drive is by eleven electric motors with a total output of 1658 h.p.; nearly 1.7 miles of steel wire rope or cable is used for reeving. The ladle to be used will be over 17 ft. high, 17 ft. top diameter, and will hold 375 tons of hot metal. Self-equalizing four-wheel trucks, each weighing 20,000 lb., are used; bridge wheels can be changed quickly. The main trolley frame (47.5 by 30.3 by 11.9 ft.) was designed to be shipped in about eight sections, re-assembled on the bridge by bolting with high-tensile bolts, and welded in the field. A five-deck cage housing the electrical equipment and crane operator is over 46 ft. deep from the top of the crane runway rails and the 31,300 cu. ft. volume enclosed is about three times that of a normal five-room house. Welded construction is widely used.

EUROPE'S LARGEST SUSPENSION BRIDGE

French Economic and Technical Bulletin, No. 11, 1956

The 77 miles of the river Seine from Rouen to the English Channel present an obstacle to traffic as there are only ferry crossings in this reach. Studies over a long period indicated that a suspension bridge was the best solution for overcoming the inherent difficulties of providing a suitable crossing, and construction is now under way on a bridge at Tancarville, near Le Havre. This will cost over $11.5 million and is due to be completed in spring, 1959.

Three suspended spans will support a continuous metallic roadbed, 3152 feet long between two anchorage blocks. Total length, with the left-bank approach, will be 4593 feet; clearance over the river will be 160 feet. The bridge will require some 2,000,000 cu. ft. of concrete, including over 700,000 for the two anchorage blocks and nearly 900,000 for the superstructure and tower foundations.

Fifteen thousand tons of steel will be used, including 3210 tons for the supporting cables and vertical sling cables. The two supporting cables, suspended from four 426-ft. high reinforced-concrete towers, will each be 0.6 mile long and made of 56 elementary cables (for a total of nearly 15,000 miles of solid steel wire strands). Maximum stress for each cable will be 8500 tons.

The prestressed concrete anchorage block on the left bank will consist of two parallel walls in the longitudinal axis of the bridge. Average height of the block will be 147 ft., length at top 130 ft., and length at base 153 ft. The forward section of each wall rests on a caisson 72 by 26 ft., filled with concrete. In the rear, the wall will rest on a caisson, 33 by 16 ft., also filled with concrete and fill.

The two walls will be 52 ft. apart and connected by struts, arranged in some cases to contain ballast. Difficulty was caused by the fact that there is no bedrock on the left bank.

On the right bank, the anchorage block will consist of two structures to carry the supporting cables, two reinforced concrete chambers, and two concrete-lined galleries dug out of the rock base and forming the actual anchorage.

INDUSTRIAL APPLICATIONS OF MICROCALORIMETERS

Prof. H. Prat, Dept. of Biology, University of Montreal

The Calvet micro-calorimeter is described with details of construction of the apparatus, the accessory devices, and its numerous applications in pure and industrial research, in the book: "Micro - calorimétrie; applications physico-chimiques et biologiques" by E. Calvet and H. Prat. (Masson, editor, Paris. 1956.)

In its most common form the apparatus consists of four calorimetric groups, each one containing 192 thermo-couples radiating in 12 super-stars of 16 around a cell of 18 mm. diameter. These thermo-electric piles are connected in two opposing pairs with two high sensitivity galvanometers. The whole is placed in a set of five successive enclosures made in either aluminum or copper. The penultimate is provided with a temperature stabilizing device (heating or refrigeration by thermostatic control) and the space between it and the external enclosure is filled with a thermal insulant (asbestos or polyethylene foam).

This apparatus does not operate as an adiabatic calorimeter (without loss or gain of heat) nor as an isothermic one (with total compensation), although it is totally insulated and its variations in temperature are very small (of the order of one thousandth of a degree). Its principle is as follows: the thermal capacity of the investigated material is relatively small compared with that of the enclosures; thus the heat produced is rapidly absorbed by the mass of the apparatus, permitting very little variations in the temperature of the cell. Under these conditions A. Tian has demonstrated that the electromotive force produced by the thermo-electric pile is proportional to the thermal output; that is to say, the calories produced per unit time. In practice the deviations of the galvanometer may be calibrated in calories per hour. On a chart a continuous curve is obtained (a *thermogram*) giving thermal output as the ordinate and time as the abcissa. Mounting the piles in opposition assures the stability of the zero and permits differential or additional combinations if desired. Finally the thermo-couples are connected in such a way that it is possible to use some of them to generate a Peltier effect (cooling of junctions), thus to obtain a partial compensation of the heat, when the deviation is too great.

These improved apparatuses have been available for only about eight years and, up to now, only a few have been built. In France six of them are in operation. In Canada three are currently being used at the University of Montreal and one at the University of Ottawa. Six more are in process of construction at Montreal, Marseilles and Lyons. In spite of their small number the twelve apparatuses in operation have already produced considerable results in various fields; for example, in laboratories working in industrial chemistry, agronomy, microbiology, entomology, pharmacodynamy; for fundamental research as well as for applications, apparatus of this type are expected to become as useful as spectrophotometers or precision balances. To give an idea of their sensitivity, the thermogram of a single small fruit fly *(Drosophila)* weighing one milligram can be clearly recorded. Outputs of heat representing one ten-thousandth of a small calorie can be recorded and measured.

In addition, in order to extend the possibilities of the apparatus, E. Calvet has now constructed micro-calorimeters capable of operating at high temperatures, others at sub-zero temperature, and yet others with cells of 35 mm. diameter capable of holding larger animals. This pioneer work is extremely promising, both from results already obtained and by the variety of its possibilities.

LABOUR IN CANADA

The forty-fifth annual report on labour organization in Canada has been published by the Department of Labour. It contains the results of the 1956 survey of union membership carried out by the Department. The report includes a statistical analysis of union membership and, secondly, a directory of labour organizations giving officers, publications, and location of Canadian branches.

STEEL EXTRUSIONS THAT SAVE MACHINING TIME

The picture above shows an unusual steel extrusion made during a research and development project of Allegheny Ludlum Steel Corporation. The particular extrusion die was designed with a ratio of cross-sectional area to perimeter of 1 to 10, thus imposing high stresses in the complex die. However, twelve-foot lengths of type 410 stainless steel were extruded at production speeds and at production temperatures. The company is already producing steel extrusions of an airframe section for the aircraft industry; previously made of bar stock, the SAE carbon steel extrusions are said to save 75 per cent in machining time. Conditions for extrusion from a 25 sq. in. billet to an 0.4 sq. in. T-section are severe: 150,000 p.s.i. at about 2250 deg. F. produces 25-ft. lengths of 0.140 in. thickness at speeds up to 45 m.p.h.

SANDS OF THE SEA

F. A. Hauck, *Yale Scientific Magazine,* v. 31, no. 4

Deposits of minerals which are becoming increasingly important in the atomic and electronic applications of industry are found in the sand dunes of Florida. In the last few years successful recovery methods have been devised based chiefly on the specific gravity, magnetic, and electrostatic properties of the minerals which are monazite, rutile, ilmenite, zircon, and garnet. During geological time, particles of the deposits have found their way from the mountains by wind, rivers and streams, ocean tides and currents, storms, and perhaps by subterranean streams to their resting places on the beaches. There are both shore line beaches and others at some distance inland indicating partial elevation of the coast line subsequent to the decomposition of the rocks. Where water from waves and tides wash the shoreline these minerals, which are much heavier than silica sand, are separated from the lighter sand and accumulate in rich deposits, sometimes as high as 90 per cent concentrates. The incoming wave carries the minerals with the silica sand to its crest. At the crest of the wave the water momentarily stops, at which instant the heavy minerals fall while the lighter silica sands are carried back with the receding wave. This goes on hour after hour and when the wind is in one direction for days quite a depost is formed of heavy minerals, sometimes several inches thick. In this way alternating layers of mineral and of silica sand comprise rich deposits on the shore of the ocean in the area.

A peculiarity of the Florida deposits is the uniformity of the ratios of the minerals — ilmenite 45-55% of concentrates, rutile 10-20%, zircon 10-20%, garnet 10-15% and monazite 1.5%. A wet separating plant consisting of a dredge, screening equipment, and rougher is set up at the source upon a man-made lake. This recovers a primary concentration of mixed heavy minerals (60 to 80 percent in the product) which is transported to a central separation plant and the minerals are further high-graded by wet tabling and then dried. An electrostatic separation follows and is a method of recovering finely-ground mixtures, taking advantage of variations in their electrical properties to make them react differently when passed through a field of static electricity. Magnetic separation after the electrostatic operation pulls out from the concentrate all iron-bearing mineral such as the ilmenite.

The ilmenite contains 53 to 58 per cent titanium. Minerals rich in titanium are few, and only ilmenite and rutile have commercial importance. The metal is becoming increasingly important in military aircraft for air frame construction and in jet engines for compressor components. It has excellent corrosion resistance and will prove useful in the chemical industry and in marine environments. Zircon is a common widely distributed accessory mineral. It has a high melting point and is resistant to corrosion by acids and alkalis. Zirconium does not absorb neutrons easily and is therefore a splendid material for use in structural supports for nuclear reactors. Zirconium refractories can withstand temperatures up to 4500 deg. F. Hafnium is also found in zircon and its high neutron-absorption factor makes it a useful material for nuclear energy equipment. Zirconium is suitable for use in surgery. Body fluids will not corrode it and human tissue grows to it without decay or deterioration. It may replace tantalum in dental and surgical work.

Ultimate Strength Design of Reinforced Concrete Beams

(Continued from p. 808)

sufficient security. Most European codes have taken care of this condition by lowering the allowable concrete stress if the calculated position of the neutral axis falls a certain distance below the bottom of slab. One code takes care of this condition in perhaps a more logical manner. The total resistance of the concrete section is the sum of resistance of the projecting part of the flange with allowable concrete stress as for direct loading plus the resistance of the beam stem to top of slab with allowable stress as for a rectangular beam. Our reinforced concrete building code should certainly be corrected to take care of this condition.

Conclusion

It seems to be clear that it would be necessary for a designer to have a very clear understanding of the fundamental facts of reinforced concrete if he should base his design work on ultimate strength of reinforced concrete beams. There may perhaps be some doubt if all of those who now design by means of tables and formulas have this knowledge. The above discussion would indicate that no change of design method is needed for normally reinforced beams. The question might then be asked if a more realistic stress calculation (which would hardly change the end result) of the over reinforced or double reinforced beam is of sufficient importance to warrant the abandonment of our present method.

There is still a considerable difference in opinion about what the basis for design by the plastic or ultimate load theory should be. (5) It has been stated that up to 1951 there were 23 different proposals of which 10 were markedly different. (6) Perhaps some day a method will be worked out which will be both accurate, consistent and simple to apply. Until such time, we probably will do well to use our present method with such improvements as are found to be desirable.

The author is quite aware that there is a great difference of opinion about the present method versus plastic or ultimate load methods of design of reinforced concrete beams. This matter certainly deserves thorough consideration and it would be desirable that other engineers do their share in helping to clarify this contentious question.

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Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

Progress during the month of March was highlighted by diversion of the river through the completed stage 1 of Long Sault dam at the end of March, after removal of the final plug in the cut through Long Sault Island.

Full scale concrete placement operations were resumed on the American half of the power-house, while at Iroquois dam, with stage 1 completed, the upstream dike was nearing completion. Five channel improvements by the two power authorities showed 63 per cent of completion at month's end.

On the Canadian side, the Cornwall canal diversion was completed and ready for navigation; on the railroad diversion most of the signal system had been installed and five railway stations were being built. The final house moving program for Long Sault (New Town No. 2) was completed while preparations were started for the major house moving program at Morrisburg.

Employment during March averaged 2750 persons on the American side and 3650 on the Canadian side.

Progress by Ontario Hydro

During April the work force was increased. There was a total of 4,150 persons employed on the various sections of the project at month end. Dry, favourable weather in April aided construction greatly and permitted first dike building in 1957 to commence. The dike work was started at the power-house area, also at the closure structure and at the north end of the dike line near Mouinette.

By the end of April all the concrete had been placed for ten draught tubes and was proceeding on the eleventh. The deck for the erection bay had been completed over the north end ice sluices. A total of 555,000 cubic yards of concrete had been put into the Canadian half of the power-house structure. Seven speed rings had been erected for the generating station. The turbine cases had been put in position over six of these rings and the meticulous work of aligning the speed rings was in progress.

Relocation of the 40-mile C.N.R. main line between Cardinal and Cornwall was virtually finished and ready for freight trains. The line is controlled by a double track block signal system and this is fully installed in the new sector and tied in with the existing main line. Telegraph and dispatchers' lines are in operation and the automatic crossing protection is functioning. Construction of the five new stations is well advanced and these depots are expected to be ready for passenger service in June.

In April, the channel improvement work at Iroquois Point continued at a favourable rate even with interruptions for trucks hauling away material caused by the canal bridge being in operation with resumption of the navigation season. The excavation to month end amounted to 1,350,000 cubic yards.

Channel enlargement work at Point Three Points had been intermittent. A start had been made in excavation there and roads to the disposal areas had been prepared. At the Galop contract wet conditions slowed down activities. A total of over 11,000,000 cubic yards of earth and rock had been removed from the new channel. Dredging had been resumed in the Chimney Island channel section and over 30,000 cubic yards had been taken out from the river bottom.

Services were held on April 21 in the Presbyterian church, the first new church in Iroquois to be opened. During the month ground was broken for the construction of the United Church, the separate school and the new town hall. Tenders have been called for building the new Anglican church which will complete all the major contracts for Iroquois. Iroquois' new shopping centre was occupied by the merchants who opened their new stores for business during the month.

House moving operations were centred in Morrisburg with 22 houses moved during the month, for a total of 45 homes moved to date, in that community. Work commenced on the plumbing rough-in for Morrisburg shopping centre and construction of 36 rental housing units was begun. Erection of the elevated water storage tank was completed in April. Concrete work for the new railway station was finished and the freight shed erected.

At the new towns of Ingleside and Long Sault, work was concentrated on grading roads, ditches and building of sidewalks and culverts. Construction was begun during the month in Ingleside on two churches and the separate school. At Long Sault, building of the elementary school and the separate school was started.

Ontario Hydro announced the award on March 15 of a contract for the construction of grade separation, C.N.R. relocation and Highway No. 31. The successful bidder was the St. Lawrence Construction Company Limited of Quebec, the amount of the tender being $641,289. The work is to be completed by June, 1958.

Progress by NYPSA

Weather conditions in April were favourable and overall construction continued on schedule. Concrete placement for all features passed the one million cubic yard mark and excavation had exceeded 37.5 million cubic yards. Employment averaged 3,900 for the month.

On the American half of the Barnhart Island power-house concrete placement operations continued at a rapid pace, as approximately 53,000 cubic yards were placed during the month, bringing the total to date to 523,000 cubic yards. Erection of the 150-ton travelling crane was completed and erection of the 300-ton gantry continued. Installation of turbine bedded parts was continued, with stay ring set for unit 20.

Concrete was placed in the various switchyard structures concurrently with excavation of the tunnel between the power plant and the switchyard. Contractors for the power dam and switchyard electrical work arrived at the job site.

With completion of diversion at Long Sault dam, rock, gravel, and earth materials were being placed on the upstream side of cofferdam E and on the downstream side of cofferdam DD to seal off leakage. Excavation for the north abutment was proceeding.

At Iroquois dam, concrete placing operations were stepped up as approximately 15,000 cubic yards were poured in the sections of the spillway and west bulkhead block.

At Massena intake, construction of the upstream cofferdam cells was progressing. Placement of fill in the downstream rockfill cofferdam was completed and the entire flow of the canal was diverted through the stage 1 structure on April 23. Excavation work under the five channel improvement contracts was progressing at an accelerated rate and was approximately 65 percent completed.

Continued good progress was being made by the reservoir clearing contractors with 4,600 of the required 11,000 acres cleared to date. Clearing of the right of way for the Barnhart-Plattsburg transmission line was completed with only the chemical treatment remaining under the contract. Materials were being unloaded and structures were being staked out for the transmission line.

A contract was awarded for construction of bridges on state highway route 345 and Franklin Road in Waddington, New York.

Progress by SLSDC

SLSDC officials reported at the end of March that the American share of the seaway locks and navigation channels was 30 per cent completed, based on contractor's earnings and government costs.

About a million cubic yards of earth were moved during the winter from the Long Sault navigation channel, bringing the mainland portion to 55 per cent of completion at the end of April, while across Long Sault Island it had been completed. No work was done on the American dikes during the winter.

Work was resumed early in April on the two American locks. By the end of April half the concrete had been placed in the Eisenhower lock and guide wall, while the lock structure itself was built to half the height throughout its length. Placing of concrete in the Grass River lock was about 45 per cent completed. Two contracts have yet to be awarded for the channel excavation below this lock.

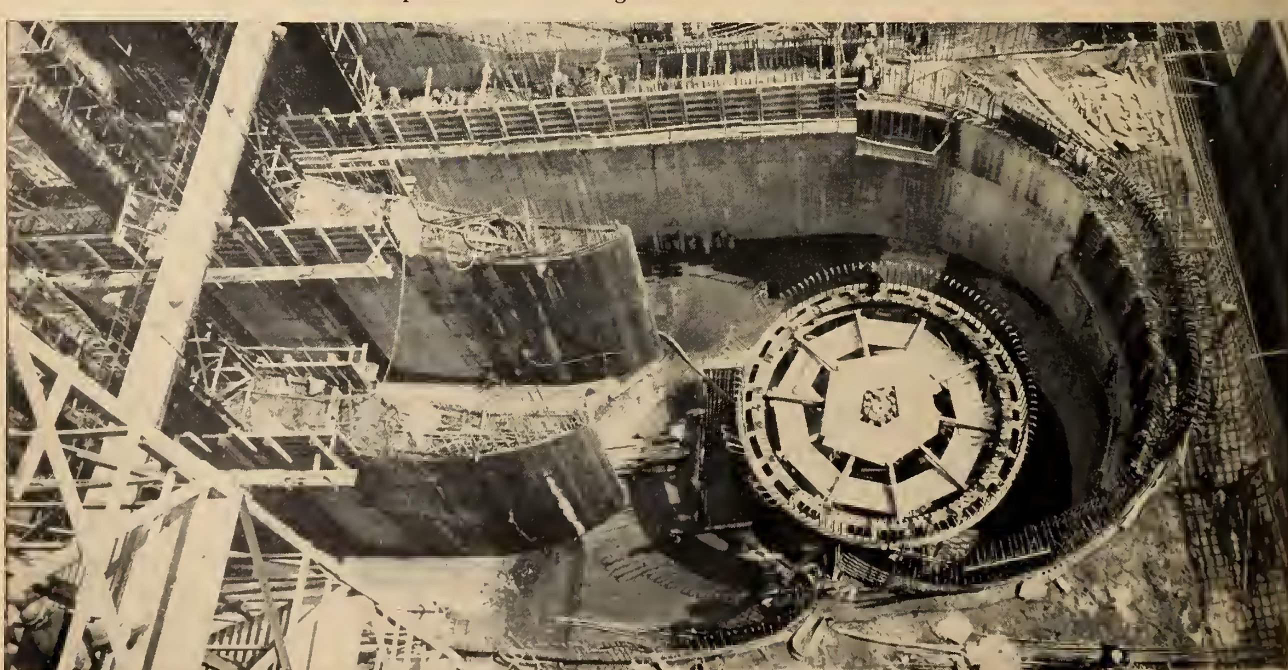
Dredging in the Thousand Island section, started last fall but closed down for the winter, was resumed in April. Two U.S. dredging companies were reported ready to commence in April on a $22 million contract for dredging 600,000 tons of clay and rock from the Amherstburg channel in the Detroit river, deepening it to 27 feet.

International Bridges

Contracts were awarded in March for the first section of the substructure for the Ogdensburg-Prescott Bridge, comprising four piers and cable anchorages for the 2150-ft. suspension bridge with five further contracts to follow for superstructure and approaches. The main span will be 1150 feet in length with side spans 500 ft. each.

There are also twelve 250-ft. deck-truss spans and seventeen 128-ft.

St. Lawrence power dam — looking down on scroll cases of units 31 and 32.



deck girder spans. The bridge is being built for the New York State Department of Public Works. Operating the structure will be the Ogdensburg Bridge Authority. New York will advance $15 million, to be repaid by revenue bonds after the bridge is opened.

U.S. Seaway Channel Costs Almost Doubled

SLSDC Administrator Lewis G. Castle testified before the House of Representatives Appropriations Subcommittee in April that United States Seaway expenditures were now estimated at $133 million, compared with the original estimate of $68 million. Price rises since 1952 account for $19 million of the increase; added construction items account for $37 million and design changes for $12 million. SLSDC was asking Congress to authorize an additional loan of $35 million from the treasury, to be amortized through toll charges over 50 years.

The additional funds were needed he said, to meet unexpected expenditures. Costs of $24 million for dredging the north and south channels of Cornwall Island were to have been paid by NYSPA and Ontario Hydro. The power agencies had objected and 1½ years were spent in discussions. A compromise called for SLSDC and SLSA to pay $6 million each toward the work. Bids on the dredging, however, were substantially above the estimate of $24 million.

Progress by SLSA

By the end of April, with dredging operations being resumed after the April 15 opening of navigation on the Lakes, and with resumption of channel excavation on overland sections, activity was general on the 1957 season's program. Placing of concrete was recommended in mid-April on the St. Lambert lock, where cleaning out of the excavation had been the only work done during the winter months. Preparations were under way at the Cote Ste. Catherine lock for pouring concrete again early in May.

At the Iroquois lock, with entrance wall and upper gate section done, lower gate section half completed and half the chamber walls poured to full height, the contractor had caught up with the schedule. Excavation was 95 per cent completed and 225,000 yards of concrete placed. One derrick was installed and permanent upstream stoplogs were in place.

On the Upper Beauharnois lock with more than a third of the earth and rock excavation done, placing of concrete for piers on the New York Central bridge would soon be under way. On the lower lock, with excavation for highway tunnel and for the lock completed, concrete was all placed for the highway underpass and about half the pavement poured on the road approaches.

At the Jacques Cartier bridge, with traffic passing in both directions over temporary Bailey bridge spans since December, the Dominion Bridge Company was jacking up four bridge spans at the south end and had raised them vertical distances of some 15 feet to connect with a temporary bridge abutment which had been built at the south shore end by the National Harbours Board.

No work had yet been started on the Victoria bridge, although at the Caughnawaga (CPR) railway bridge railway forces were doing some filling. At the Honoré Mercier bridge the temporary diversion approach fills had been built and were in service, while two contracts had been awarded for raising and widening the bridge piers and another contract for raising the superstructure.

Subsidies a Threat to Canadian Trade

Hearings concluded at Chicago early in April on applications for subsidies to U.S. ships from American ports to the Caribbean and South America disclose the basic difference between U.S. and Canadian shipping policies, which have already led to Canadian insistence on a separate Cornwall canal in the future. Applicants asked the U.S. Maritime Board to declare the U.S.-Caribbean routes essential—the initial requirements for payment of subsidies.

No Early Decision on Tolls

SLSDC Administrator Lewis Castle and SLSA President Lionel Chevrier announced early in March, following a conference in Washington, that "it would be months and maybe not until next year" before it is decided how much ships will have to pay in tolls to pass through the Seaway. However in spite of costs exceeding original estimates, tolls would not be higher than originally considered, but would be met by spreading out the repayment period.

Discussing the Welland Canal, Mr. Chevrier said tolls would be charged for ships using it when the present $25 million improvement work is completed. Presumably the charge for passing through it would be included in one over-all seaway toll. The two seaway officials also indicated they were near a decision on the maximum size for ships using the seaway.

Seaway News

$57 Million for Port of Montreal

Transport Minister George Marler announced on May 1 a $57 million program of capital works for port facilities at Montreal. Some of the work had already been completed and contracts amounting to $17.6 million had been awarded, he said. Tenders would be called shortly for other works.

The expected pattern of grain movement along the seaway is chiefly responsible for the outlay, which is exclusive of the cost of the Nun's Island Bridge. Largest single item is $27 million for improvements to the port's elevator system, increasing storage capacity by 44 per cent and increasing loading and unloading capacity by 80 per cent.

Additional wharf facilities will cost $17 million. Transit sheds will cost $5 million. $7½ million has been earmarked for dredging, part of it to enable 35,000-ton tankers to use the refinery wharves at the east end of Montreal.

Gavsie Succeeds Chevrier as SLSA President

It was announced on April 25 that Charles Gavsie, C.B.E., Q.C., formerly vice-president of the Canadian Seaway Authority, would succeed the Hon. Lionel Chevrier as acting president. Mr. Chevrier becomes President of the Council as one of the Ministers in the Liberal Cabinet at Ottawa. He will be responsible to the Canadian Cabinet for the St. Lawrence seaway.

Mr. Gavsie is an honours graduate of Dalhousie University, Halifax. Following a post graduate course at Harvard, where he received his master of laws degree, he practiced law in Montreal until he went to Ottawa in 1941. He served as general counsel of the Department of Munitions and Supply and later of the Department of Reconstruction and Supply. In 1948 he transferred to the Department of National Revenue as assistant deputy minister and was appointed deputy in August 1951.

Water Power Resources of Canada

The Water Resources Branch, Department of Northern Affairs and National Resources, Canada, in its annual review Bulletin 2570, records water-power resources of Canada as totalling 32 million horse-power under conditions of low stream flow and over 57 million horse-power at average flow. The latter figure represents a feasible turbine installation of about 74 million horse-power. The total turbine installation at the end of 1956 is given as 18,356,148 hp. indicating that less than 25 per cent of available resources has been developed.

During 1956 hydro-electric construction was accelerating and new capacity to the extent of 845,000 hp. was brought into operation with good progress made on other new developments; additional projects also were being investigated or planned. Of hydraulic plants, 87 per cent serve as central electric stations and, in 1956, production reached a new high level. The pulp and paper and the mineral industries are the more important consumers of hydraulic power. The installed capacity of water-power plants in Canada now equals 1,149 hp. per thousand of population.

Table II — Industrial Distribution of Developed Water Power At End of the Year 1956

Province or Territory	Turbine Installation — H.P. Central Electric Stations	Pulp and Paper Mills	Other Industries	Total
1	2	3	4	5
British Columbia	1,163,340	141,270	1,210,350	2,514,960
Alberta	282,950		2,060	285,010
Saskatchewan	109,800		35	109,835
Manitoba	795,000		1,900	796,900
Ontario	5,139,417	223,507	80,842	5,443,766
Quebec	8,084,153	350,344	55,460	8,489,957
New Brunswick	134,700	23,872	5,558	164,130
Nova Scotia	164,705	10,337	4,676	179,718
Prince Edward Is.	369		1,513	1,882
Newfoundland	140,450	182,300	14,000	336,750
Yukon & N.W.T.	13,540		19,700	33,240
Canada	16,028,424	931,630	1,396,094	18,356,148
Percentage	87.3	5.1	7.6	100.0

Table I — Available and Developed Water Power in Canada At End of the Year 1956

Province or Territory	Available 24-hour power at 80% efficiency — H.P. At Ordinary Min. Flow	At Ordinary 6-Months Flow	Installed Turbine Capacity H.P.
1	2	3	4
British Columbia	10,200,000	17,300,000	2,514,960
Alberta	508,000	1,258,000	285,010
Saskatchewan	550,000	1,120,000	109,835
Manitoba	3,333,000	5,562,000	796,900
Ontario	5,407,000	7,261,000	5,443,766
Quebec	10,896,000	20,445,000	8,489,957
New Brunswick	123,000	334,000	164,130
Nova Scotia	25,500	156,000	179,718
Prince Edward Is.	500	3,000	1,882
Newfoundland	958,500	2,754,000	336,750
Yukon & N.W.T.	382,500	814,000	33,240
Canada	32,384,000	57,007,000	18,356,148

Table I lists the total water power resources of Canada and the present total capacity of all water power plants.

The figures in Columns 2 and 3 do not include the power potential of major river diversions that have been investigated but not developed. For example, in British Columbia the potential of the Chilko River itself has been included, but not the potential of the Chilko-Homathko River diversions quoted in other publications as 1,000,000 hp. A number of other major diversion possibilities exist, particularly in British Columbia, where topographical conditions favour such rearrangements of flow. The addition of these potentials may be necessary to reconcile these figures with those from other sources.

Many unrecorded power sites exist on streams throughout the country, particularly in the less explored northerly districts, but these cannot be included until more detailed survey work has been completed. Thus the listed figures of available power represent only the *minimum water-power possibilities of Canada.*

Because excess capacity is usually installed at developed sites, the figures of Column 4 are not directly comparable with those of Column 3; that is, in computing the relationship between the figures of presently developed power and those of total resources, Column 3 should be increased by 30 per cent. On this basis, the figures of power available at Ordinary-Six-Months Flow which total 57,007,000 hp. may be said to be conservative as *these presently recorded water-power resources of Canada* will permit an economic turbine installation of about 74,000,000 hp.

Remaining reserves of not-too-distant power are sufficient to meet the prospective needs of a considerable part of the more closely settled areas for some years at the very least; also, improvements in the technique of long-distance transmission, including the use of higher voltage, are bringing additional sites within the orbit of existing systems. In more remote districts, water power will facilitate the utilization of mineral and other resources and promote the establishment of new communities; from the viewpoint of moving Canada's frontiers northward, the availability of considerable amounts of potential power in the more northern and at present rather inaccessible regions of the country is a definite advantage.

Progress In Development During 1956

In 1956, the appreciable amount of 845,000 hp. of new hydro-electric generating capacity was brought into operation in Canada. Construction also was active on a number of other projects comprising about 3,500,000 hp. to come into operation in the years 1957 and 1958, while an additional 4,500,000 hp. was under preliminary construction or under planning for later years. A detailed review of new and prospective developments was given in the Branch's free bulletin No. 2551 "Hydro-Electric Progress in Canada, 1956" which was issued in January 1957, and is still available upon request.

Utilization of Developed Power

For the purpose of showing the general manner in which developed water power in Canada is utilized, Table II lists the hydraulic installation of each province under three industrial divisions.

In table II, Column 2 includes only hydro-electric stations which develop power for sale. Column 3 includes only water power developed directly by pulp-and-paper companies for their exclusive use. Column 4 covers water-power installations made by other industries and used solely for their own purposes. Column 5 totals all hydraulic turbines and water wheels installed in Canada.

Canadian Pipeline Projects

Westcoast Transmission

Canadian Husky Oil Co. of Calgary has announced an agreement with Westcoast Transmission and El Paso Natural Gas Co., allotting its 32½ per cent interest in the Savanna Creek gas field to Westcoast. With the 27½ per cent interest in the field recently acquired from Phillips Petroleum Co., Westcoast will thus control half the output from the field. El Paso has offered to advance $2 million to Husky towards Husky's development costs for the field, to be repaid from half the proceeds of gas sales to Westcoast. El Paso has also invested $3 million in Canadian Husky common shares.

Inland Natural Gas Co.

Because of an unusually mild winter in the interior of British Columbia, additional financing for a $15 million issue was moved ahead. Three spreads were already working on the main line, with three more working on distribution systems. Most of the pipe had been delivered, with the balance expected by the end of May.

Alberta Gas Trunk Line

Construction of the Alberta Trunk Lines gathering main was under way at the crossing of the Red Deer River early in April, with pipe laying scheduled to start as soon as the frost was out.

A 4000 ft. suspension bridge will span the South Saskatchewan river. When the Provost-Bindloss sections are completed, gas from these fields will be available to feed Trans Canada's first customers at Winnipeg.

In 1958 the Company's main pipeline is scheduled to be carried 64 miles west to its three-way junction point, while a 149 mile, 24-inch line will be run from Pincher Creek, Cessford and Sunnybrook. Expenditures on construction will amount to $11 million in 1957 and $29 million in 1958.

Alberta Gas Trunk awarded contracts late in April for the first part of its gathering system to Fulton Banister, Ltd. The contractor will start by mid-May on the first section which includes 17 miles of 34-inch main from the Western Terminus of Trans Canada at Burstall to a point near Cavendish, Alberta. From Cavendish he will build 84½ miles of 18-inch line north to Provost. The contract, worth $10,963,000, is due for completion in September. The line will initially draw gas from the Provost and Bindloss fields.

Trans Canada Pipelines

By early April most pipeline work had come to a temporary halt due to road bans. Stringing had been completed on sections 3 and 4 during the winter. Dunn Brothers (Canada) Ltd. had strung 35 miles of 34 inch pipe on section 5 between Miniota and McGregor and were moving to section 6. A second loop was pulled at the Assiniboine crossing late in March.

The first shipment of 30-inch pipe from Britain for the line east of Winnipeg reached Halifax on March 18, and was forwarded by rail to Lorette, Man. More than 70 shiploads will be required to complete the 200,000-ton, $32 million order. Further 30

Operators make inside and outside welds on pipe at the Price-Poole double joint yard, Crandall, Man.

inch pipe will be obtained from Welland Tubes Ltd.

Pipe deliveries on the 34-inch pipe were completed by the end of April, including the pipe for sections 4 and 5. Delivery of the 30-inch pipe for section 7 east of Winnipeg will commence in May or June.

Marine Pipelaying and Dredging Co. had completed welding of the 34-inch pipe at the Red River crossing by late April, but crossing will not be laid until the river flow is down to normal summer levels. Majestic had started rock drilling on section 7 but pipelaying was not expected to commence before June. Pipelaying on the balance of the 34-inch line had been suspended until the road bans were lifted but stockpiling and double jointing was continuing on sections 5 and 6.

Northern Ontario Pipeline Crown Corporation

Contracts for clearing right of way along the northern Ontario section of Trans Canada from the Manitoba-Ontario border to Port Arthur were awarded on April 2. These contracts covering a distance of 315 miles, involve an expenditure of $807,225. The two remaining clearing contracts were awarded in mid-April to Harris Construction Co.

Tenders closed on April 26 for grading and pipelaying on this 315 miles between the Manitoba border and Port Arthur, divided into four sections. Trans Canada engineers will supervise construction. Engineering and design was handled by Trans Canada for the Crown Corporation.

Interprovincial Gas Purchased

Consumers Gas Co. of Toronto has acquired the physical properties of Interprovincial Utilities Co. which supplies manufactured gas to the Ottawa-Hull area. The purchase price is about $2.7 million. Plans involve a long-term purchase contract of natural gas from Trans Canada, and Trans Canada will push construction of the 40 mile line extension from Morrisburg to Ottawa. Meantime Interprovincial will continue to supply the Ottawa-Hull area with manufactured gas.

Quebec Natural Gas Takes Over

The Quebec Natural Gas Corporation offering of $12½ million in Canadian bonds and $7.45 million in U.S. bonds was made during the week of April 20. The Canadian offering also included $20 million of 5¾ per cent debentures and 800,000 shares of common stock. Shortly thereafter operation of the system was taken over from Hydro Quebec by Quebec Natural Gas Corporation.

FPC Hearings to Reopen

The Federal Power Commission set May 14 as the date for hearings on applications to serve the midwest United States with natural gas. FPC ordered the consolidation of proceedings for hearings to commence on 20 applications by nine pipeline companies, all relating directly or indirectly to natural gas services in the midwest states.

Hearings are in connection with the proposal by Midwestern Gas Transmission Co. to build a pipeline system from Portland, Tennessee, to the U.S.-Canada border where it would receive 204 MM c.f.d. from Trans Canada. Another 204 MM c.f.d. would be purchased from Tennessee Gas Transmission at Portland.

Three other companies are proposing to build competitive projects which are mutually exclusive in part with facilities proposed by Midwestern. Applications from five other companies have an independent relationship to the other proposals.

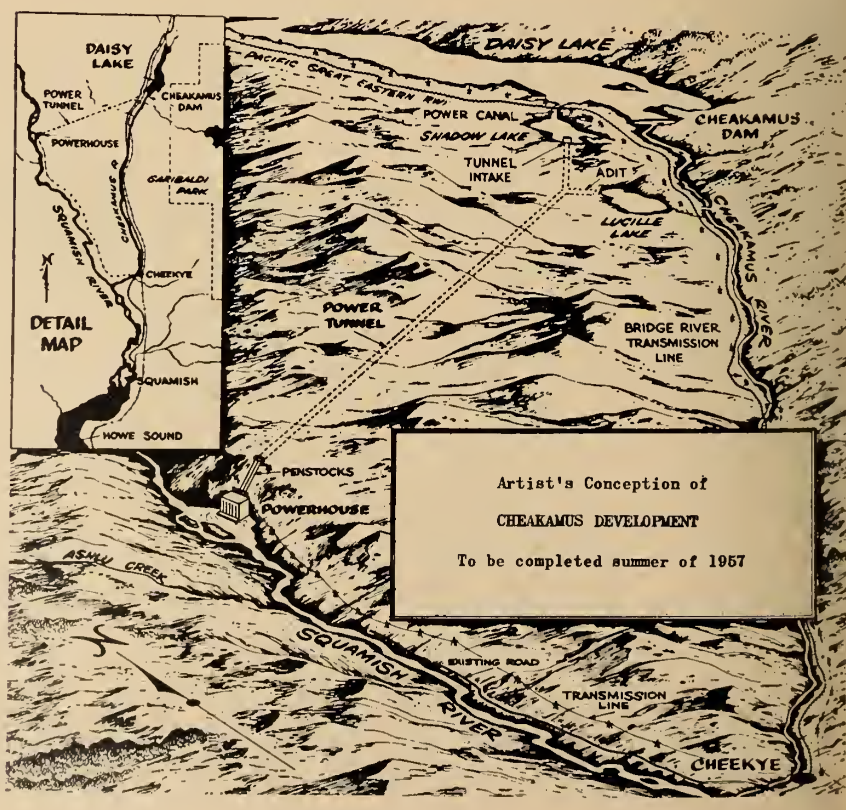
The FPC has announced it would not accept any further applications proposing service in whole or in part to these competitive areas.

Seven Mile Power Tunnel in B.C.

British Columbia Electric Co. Ltd., has completed a nearly seven mile tunnel through Cloudburst mountain.

The diagram illustrates the scheme: a diversion dam on the Cheakamus River, 90 feet high and nearly half a mile in length, will create a 1000-acre head pond, designated as Daisy Lake. A 3000-ft. canal will carry the water to Shadow Lake, 1240 ft. above sea level, from where it enters the tunnel.

Two surface penstocks connect the tunnel with a power house on the Squamish River, which will accommodate two 95,000-hp. turbines driving two 70,000-kw. generators. The first is scheduled for operation in July, the second in December, 1957.



New Port for British Columbia

Premier Bennett of British Columbia disclosed a plan at the end of April for developing a multi-million dollar deep-sea port at Squamish, once the terminus of the Pacific Great Eastern. Two thousand acres of lowland now under sea water would be reclaimed at a cost of some $20 million for commercial and residential development, and for railway yards, factories, warehouses, etc. The shallow harbour would be dredged and three large piers developed for ocean-going vessels.

The Pacific Great Eastern, owned by the B.C. Government, will control the development. Preliminary work will be started this summer. A start on land reclamation will be made by diking along the Squamish river. The present town with it's 1800 inhabitants will be moved a mile north of its present site to higher ground. Federal Fisheries Minister Sinclair, recalling Ottawa's 1949 offer of half-a-million dollars to develop a lumber wharf there, indicated federal assistance was still available.

If the plan were carried out to its full fruition, Squamish's population might grow to 25,000 within the 25 year period visualized for its development, the Premier said. The investment would be to some extent self liquidating through the sale of industrial sites. Three major firms are anxious to establish plants in the area and many more would follow once the scheme got under way.

Squamish is still the site of the P.G.E. main marshalling yards. The railway drains off lumber, cattle, minerals and farm products from the central and northern interior of the province. Much of these could be processed around Squamish, since hydro power is abundant. The town is also the jumping-off point for the Garibaldi Park recreational area.

Baffinland Aerial Survey

Canadian planes have been mapping the Antarctic for the British Government. Two Canadian Cansos have carried out 40,000 square miles of aerial photography in the rugged Grahamland Peninsula in the Antarctic. The two aircraft are part of a fleet of Kenting Aviation, flying arm of The Photographic Survey Corporation, Toronto.

Now the PSC has undertaken a commercial mapping expedition for the Canadian Government in Baffinland to obtain lattice photographic coverage of some 40,000 square miles.

This operation will continue the Government's Shoran-controlled survey of the north, which was begun in 1947 by the Canadian Goedetic Survey.

A B-17 Flying Fortress is being used for the survey, with support from a Canso amphibian for bringing out the crews and equipment after the ice break-up, a DC-4 for airlifting the personnel and material to Foxe Inlet on Melville Peninsula in May, and a DC-3 Dakota to relay them to eight Shoran sites, all to be occupied simultaneously.

Base of the expedition is an airstrip at Foxe Inlet, some 2,000 miles north of Toronto. At Foxe the photographs, taken on day to day flights at heights up to 28,000 feet and spaced at intervals of approximately 20 miles, will be processed and then inspected by a government official. Film processing will be done at Foxe and the film will be forwarded to Toronto.

The airlift began in May, and photography started about the first of June. Preparations started last summer when 100,000 gallons of fuel were shipped to Foxe. A reconnaissance flight was made last August by a Canso, and another earlier this year.

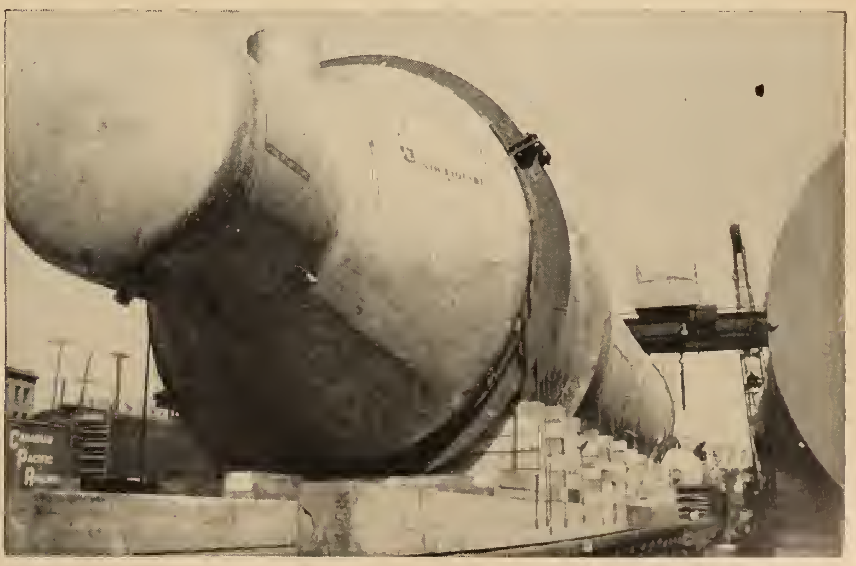
Firm Ships Chemical Equipment to U.S.

Fractionating units built in Canada for the low temperature separation of gases, part of a 300-ton-per-day tonnage oxygen plant were recently completed and shipped to a large chemical company in the United States by L'Air Liquide, Montreal (engineering and construction affiliate of Canadian Liquid Air).

Consisting of four vessels of unusually large size: a high pressure column, 24 ft. long by 8½ ft. dia., low pressure column, 48 ft. long by 9 ft. dia., vaporizer, 34 ft. long by 6 ft. dia., and exchanger, 19 ft. long by 3½ ft. dia., the whole assembly required two railroad flat cars and a gondola car to transport it.

All-welded of stainless steel, these fractionating units are the heart of a huge air separation plant designed by L'Air Liquide to produce 300 tons of oxygen and 140 tons of pure nitrogen per day. To accomplish this, the plant will have to process 1,875,140 cubic feet of atmospheric air every hour. Separation of the gases from the atmosphere by this process is carried out at temperatures in the vicinity of 300 degrees (F) below zero,

Fractionating column being shipped to U.S.A.



when the air becomes liquid and flows like water. This liquefaction process is also widely used for the separation of hydro-carbon gases in the petroleum industry.

The oxygen and nitrogen from this plant are to be used in the synthesis of a number of chemical products.

What Goes On

Great Lakes Power

A $5 million issue of Great Lakes Power Corporation 5¾% debentures has been sold at par. Proceeds will be applied to the company's development program.

The company sells power to the city of Sault Ste. Marie, and to mining and smelting, pulp and paper, and manufacturing industries in the area. A seventh hydro-electric station for the company's system is now under construction, and will bring the installed capacity to 201,000 hp. This total is expected to be 226,000 hp. by 1959. (Financial Post, May 4).

Saint John Hospital

Contracts in the value of $2.5 million were awarded recently, to put into effect the last stage of the expansion of the Saint John General Hospital, Saint John, N.B.

Completion of the $5 million scheme is scheduled for May, 1959, having been set in motion in 1952. With a power house, a nurses' residence, an expanded kitchen, dietary and laundry facilities already constructed, the next stage will supply a section to house the cobalt bomb (this unit to be in operation possibly by the end of 1957). (Financial Post, May 4).

McIntyre-Ventures

McIntyre-Porcupine Mines will acquire an interest in Ventures Ltd., according to a recent announcement of a proposed plan, the effect of which would be a change of policy for both companies. There would be more rapid development of Ventures projects in Canada and elsewhere, McIntyre providing $20 million in exchange for an initial 16 per cent interest in Ventures with options on additional shares, up to 30 per cent (Financial Post May 4).

Britain Will Buy Uranium

That Britain will buy $115 million worth of uranium from Canada during the next five years was disclosed after the March Bermuda talks between Prime Ministers St. Laurent and Macmillan.

A contract was approved at the meeting whereby the United Kingdom atomic energy authority will purchase uranium from Canada's governmental agency, Eldorado Mining and Refining Limited, which in turn has entered into purchase contracts with Canadian mining companies. This uranium, the communique said, "will greatly assist in carrying out the expanded nuclear power program of the United Kingdom". (Montreal Star, March 27).

Ontario Hydro

Ontario Hydro will start construction this spring on a single-unit, remote controlled, 43,500-kw. generating station at Silver Falls on the Kaministikwia River, about 25 miles northwest of Port Arthur. It is scheduled for service late in 1959, and it, with other developments under way, will add 206,900 kw. to the generating capacity in the Commission's north-western division by that time.

Ontario Hydro also announced recently that a fourth 200,000-kw. unit will be added to the Richard L. Hearn Station in Toronto. This will raise the total installed capacity to 1,200,000 kw.

There are now four 100,000-kw. units at this station. In addition, three 200,000-kw. units are scheduled for service in 1958, 1959, and 1960 respectively. The fourth such unit is also tentatively scheduled for 1960. This installation will mark the completion of the Richard L. Hearn generating station.

Cunard to Serve Detroit

Deputy Chairman Sir John Brocklebank of Cunard Steamship Lines Ltd. announced at Detroit late in March that his company would inaugurate cargo service into Detroit this spring in anticipation of the 1959 opening of the seaway. Two 1500 ton vessels would commence the service, with the first one due to arrive at Detroit May 7. The operation would be experimental to learn how the trade works.

McMaster Nuclear Reactor

Ottawa has issued a permit for the construction of a nuclear reactor at McMaster University. The McMaster plans, directed by Dr. H. G. Thode, principal, Hamilton College, met the requirements of the Atomic Energy Control Board, and with the approval of the atomic scientists, health and engineering authorities, construction may proceed.

The contract for the design and construction of the research reactor has already been let to AMF Atomics (Canada) Limited. Detailed plans for the reactor building itself were to be ready in May, and breaking of ground was scheduled for June. Full power operation of the reactor in the fall of 1958 is expected.

Urban Renewal in Montreal

An area comprising 19.7 acres in downtown Montreal is due for acquisition, clearance and redevelopment. The Federal Department of Public Works announced in March that the Federal Government had entered into agreements with the Province of Quebec and the City of Montreal to accomplish the project.

Acquisition and clearance of the area, bounded by St. Dominique, Ontario and Sanguinet Streets, and the rear lot lines of properties fronting on St. Catherine Street, will be undertaken by the City of Montreal with financial assistance under the National Housing Act. The maximum federal contribution will be $2,467,-587, about one-half of the estimated cost of acquisition and clearance less the price at which the land will be made available for a Federal-Provincial subsidized rental housing project. The Provincial Government has indicated that it will contribute $1 million.

The rental housing project, to be constructed under the National Housing act will consist of approximately 800 units. Capital costs of the project and rental subsidies will be borne 75 per cent by the Federal Government and 25 per cent by the City, acting as the agent of the Province of Quebec.

Rentals will be based on the income and size of tenant families, all former residents of the area being eligible for re-housing. Units not rented to these families will be offered to families with incomes of between $150 and $350 per month.

Central Mortgage and Housing Corporation will collaborate in the design and construction of this project, the first redevelopment and public housing project in Quebec under the National Housing Act.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE ELECTIONS AND TRANSFERS

No More Union In Saskatchewan

For many years the engineers in the civil service of Saskatchewan have been required to belong to a trade union. Naturally in a heterogeneous union of that kind they were a very ineffective minority.

For years they have been trying to extricate themselves from this unhappy situation and recently it has been announced that they have been successful. A Labor Relations Board order handed down recently, granted an application submitted by Bernard C. Laws, M.E.I.C., P.Eng. and Ronald E. Pelkey, M.E.I.C., P.Eng., both of the highway department, for exclusion from the collective bargaining agreement.

This development should have real significance to engineers in many parts of the country and in the United States as well. Here is a case of a group of engineers about forty in number who have been forced for years to be members of a union. They have not liked the experience and have successfully fought their way out of it.

Congratulations to the engineers in the Civil Service of Saskatchewan and to the Association of Professional Engineers who have worked with them. They have certainly been courageous and tenacious and it is nice to know that at last they have received their reward.

Change In Plans

Many members will have read in the daily press the announcement made by the Atomic Energy of Canada Limited a short time ago relative to the suspension of work on the nuclear power reactor which was to be built at Des Joachims, Ontario.

It will be a disappointment for many to know that the completion of this project is now going to be set back a substantial period of time. Canadians are taking a real pride in the advanced position in which Canada has placed herself in the nuclear field and they may well be discouraged at this latest news.

It was the good fortune of the general secretary to be informed of this move by the Atomic Energy of Canada just prior to the public announcement. At the interview in the Company's office in Ottawa the story was revealed in detail with the result that it is now realized that great praise is due to the A.E.C. for the courage they had in making this decision.

As is so frequently the case in new developments the engineers discovered as they proceeded with the design that there were other ways of accomplishing the desired results. New methods, new ideas, were found which were much more promising than those being used so that finally the company decided that in the best interests of everyone the work should be suspended temporarily.

As a matter of fact, almost every reactor being built today will be out of date in a matter of a very few years. Canada was in the fortunate position that she was not desperate for power and therefore could afford to set the whole project back a bit in order to develop safer and more economic methods.

Instead of being disappointed Canadians should be happy to know that this work is in the hands of people who have the courage to take this sort of action. The work will go on and eventually there is every prospect that the Canadian reactor will be as good or better than any other in the world when it finally comes to completion.

Herewith is the official release which puts into newspaper language the thoughts that in the previous paragraphs we have tried to express.

Atomic Energy of Canada Limited, the Hydro-Electric Power Commission of Ontario, and the Canadian General Electric Company Limited, partners in the Nuclear Power Demonstration project which is underway at Des Joachims, Ontario, announced today that construction work at the site had been suspended temporarily because of major design changes in the reactor which are now under study. The present design of the NPD reactor is based on an outline specification which was established as the result of a nuclear power feasibility study carried out by representatives of certain of the utilities, including Ontario Hydro, and the staff of Atomic Energy of Canada Limited.

Cover Picture

The cover picture is a view of the fabrication of a microwave parabolic reflector designed to transmit ultra high frequency radio waves over long distances.

Photo courtesy Dominion Bridge Company, Limited.

Important technological advances have occurred over the period since the detailed design of the NPD reactor began. These are of such significance that it seemed most desirable that an attempt should be made to incorporate them in the design of the NPD reactor even at the expense of some delay in bringing the reactor into operation. These changes in design do not affect the basic concept of the design — that is, the use of heavy water as a moderator and natural uranium as a fuel — nor do they affect the power rating of the NPD reactor, which has been established at 20,000 kilowatts electric. The work at Des Joachims has only reached the stage of preparation for the foundations. Therefore the decision to consider a change in design will not involve the abandonment of any construction which has taken place at the site.

British Engineer Speaks To Branches

It was the Institute's good fortune to have Sir Claude Gibb, K.B.E, F.R.S., chairman and managing director of C. A. Parsons and Co. Ltd., Britain, speak to nine of the Branches on the subject of Some Engineering Problems in Connection with the Development of Nuclear Energy. There are few people as well qualified to speak on this subject as is Sir Claude. He heads up one of the three great groups in Great Britain who have combined their forces in order to put that country ahead of the rest of the world in the development of this type of vital energy. Not only is he the executive head of these leading companies but he is himself one of the best nuclear engineers in the country. He is chairman of the Nuclear Power Plant Co. Ltd., and of A. Reyrolle and Co. Ltd., Britain; and president of C. A. Parsons of Canada Limited.

Sir Claude spoke at the following branches and the approximate numbers in attendance are indicated in brackets after each branch.

March	28	Toronto	600 to 700
March	29	Huronia Branch	250
April	1	London	135
April	3	Chalk River	400
April	4	Ottawa	200
April	5	Montreal	200 to 300
April	8	Winnipeg	600
April	9	Regina	200
April	10	Edmonton	165

After this tour, Sir Claude returned to Toronto on the 11th and then flew from Toronto back to London on the 12th.

This was a highly intensified tour and at the same time it was a triumphant one.

Headquarters have received reports from every center where he spoke and without exception the branch officials and members claimed that this was as fine a lecture as had ever been delivered before the Institute.

Sir Claude not only is an expert in this field but he is one of the finest speakers in the profession. He has a way of dealing with a technical subject that does not seem to make it technical at all. This, capped with his fine sense of humour, makes it

Prior to giving his lecture in Montreal, Sir Claude Gibb was entertained at luncheon by the Council of the Institute and at dinner by the executive of the Montreal Branch. Shown at the luncheon, head table, are: R. E. Heartz, Sir Claude, R. L. Dunsmore, J. B. Challies, J. B. Stirling, I. R. Tait.

Below: groups in Toronto and Montreal greet visiting lecturer. Left to right: Sir Claude, Toronto Branch chairman E. R. Davis, and President V. A. McKillop; Leo Roy, Montreal Branch chairman, Sir Claude, and Past President Heartz.

D. J. Matthews, London Branch chairman, with Sir Claude Gibb.

a pleasure to listen to every word, although to this writer and to many others in the audiences most of the words were not too well understood.

The Institute is greatly indebted to Sir Claude and to the Institution of Mechanical Engineers through whom arrangements were made for Sir Claude to come to this country to deliver the lecture for which he had been awarded the Hopkinson prize by that Institution.

The Institute in Pakistan

Recently through the Canadian High Commissioner's office an invitation was extended by the Institute of Engineers (Pakistan) for The Engineering of Canada to be represented at their fourth annual convention which took place in Karachi from March 29 to April 2.

It was the Institute's good fortune to have a member in Pakistan at that time who could attend as the representative. He was E. L. Miller, M.E.I.C., project manager for the H. G. Acres & Company Limited, who are consulting engineers on the Warsak Colony power project.

Mr. Miller has reported that the conference was interesting and successful. The principal official speaker was the Prime Minister, H. S. Suhrawardy.

The technical program included papers on a great variety of subjects including Need for Consulting Engineering Profession in Pakistan.

On the Sunday which came right in the middle of the program there were plant tours to a prestressed concrete pipe factory and several other points where the guests were met by prominent officials and were addressed by the minister for labour and works.

One innovation which has never been tried in Canada as far as the Institute is concerned is to have the conference set for a Friday, Saturday, Sunday and Monday. If the Institute could get its members to attend on these days it would be a lot simpler to get hotel accommodation than it is today.

The Institute of Engineers ("Pakistan") is built on the same basis as The Engineering Institute of Canada; that is, it caters to all branches of the profession. As would be expected in these early years of the country's history, the work underway is largely of a civil nature. It was not so long ago that the same condition was true of Canada but within recent years the industrial development has made papers available in a greater variety of subjects.

It is interesting to observe that the people of Pakistan have considered it important that they should have a national engineering society almost from the time of the birth of their country. Pakistan was established in 1947 and the Institute was established in 1952. This is but further proof, if such proof were necessary, that a profession cannot operate without a national society to represent it.

"The Future of the Western Alliance"

Once again the Institute was well represented at the annual meeting of the American Academy of Political and Social Science held in Philadelphia on April 5 and 6. This was the 61st such meeting.

The Institute's two representatives were S. Logan Kerr, M.E.I.C., consulting engineer, of Philadelphia, and W. S. Pardoe, M.E.I.C. These two gentlemen have attended these conferences on behalf of the Institute for several years.

Herewith is a report as submitted by Mr. Kerr, which is written in a very interesting style to the members of the Institute.

L.A.W.

Your two delegates to the annual meeting of the American Academy of Political and Social Science between them attended all six sessions.

The theme of this meeting was "The Future of the Western Alliance". A wide range of delegates were in attendance and a copy of the attendance record is also enclosed as a matter of information as to the scope of the meeting.

The opinions expressed by the various speakers were just as varied as the background of the speakers themselves. Several of the addresses were of very substantial interest, particularly those by Mr. de la Grandville of the French Embassy to Washington; Mr. Arthur Dean, formerly special U.S. Ambassador to Korea; Major General Biddle; His Excellency, Heinz Krekeler, Ambassador of Germany to the United States. All of these took a very objective view toward the situation in Europe and felt that NATO was acting as a war deterrent, the Western Alliance would also survive in spite of Suez, and that the effectiveness of NATO and the Western Alliance was giving the Soviets considerable worry.

The general feeling of these speakers was that the troubles in the Middle East were instigated largely by the Soviets and were part of the broad program of giving the Western Alliance and its individual members as hard a time as possible short of war.

Many of the other speakers seemed to think that much of the efforts to contain Communism or to act as a deterrent against its expansion were rather hopeless. A certain percentage of the speakers at this meeting and at previous meetings belonged to the "left of center thinking" and due allowances should be made.

The procedure was like several previous meetings attended by your two delegates, namely that the speakers were selected to promote discussion, the length of the program, left only a few minutes for discussion and this was used up by individuals from the floor making speeches prior to proposing their questions and thus the answers were limited as was the amount of discussion.

One significant history making event should be recorded, namely the 100 per cent of the members of the Engineering Institute of Canada, resident in the Philadelphia area, were present at the free luncheon on Saturday. These comprised the two official delegates and honorary member William L. Batt.

The delegates are again indebted to the Institute for the privilege of being the official representatives at this meeting.

The President

Continues his Travels

Visiting Toronto in February, President McKillop met with the officers, and attended a branch meeting. At dinner preceding the branch meeting (above) he and Mrs. McKillop and their daughter were seated at head table, with Branch Chairman E. R. Davis and Field Secretary L. F. Grant.

The two groups above right were photographed at the Toronto meeting. In the first there is Prof. J. Roy Cockburn loooking hale and hearty and thoroughly belying his 77 years, talking with branch secretary D. S. Moyer. In the second group Mr. and Mrs. George Cunningham (centre) with Mr. and Mrs. H. C. Graham.

The president visited the Montreal Branch. Left to right: R. F. Shaw, the president, Leo Roy, Branch Chairman, and Leo Nadeau, secretary-treasurer of the Corporation of Professional Engineers. He presented Institute student prizes to students at Ecole Polytechnique (at right): prize for 1956 to Pierre Fortier, and for 1957 to Gilles Gascon.

The Eastern Townships Branch marked the president's visit with a dinner and dance. Here are the head table guests. Seated: Mrs. Mawhood, Mrs. Masse, Mrs. Dunsmore, Mrs. McKillop, Mrs. Lemieux, Mrs. Wright, Mrs. Dick. Standing: Gaston Masse, George Dick, L. Austin Wright, President McKillop, Mayor Armand Nadeau, Branch Chairman Jacques Lemieux, R. L. Dunsmore, and R. D. Mawhood.

At the Mayor's office, Mr. McKillop received the key to the city, and signed the golden book. Standing, left to right: Mr. Masse, Mr. Lemieux, Mayor Nadeau, Dr. Wright, Mr. Dick, and Mr. Mawhood.

Council meeting in Toronto. Shown, left to right: P. E. Buss, Thorold, B. G. Ballard, Ottawa, L. J. R. Sanders, Galt, M. W. Huggins, Toronto, L. C. Sentance, Hamilton, T. M. Medland, Toronto, R. E. Hayes and R. F. Legget, Ottawa; in the foreground, D. D. Whitson, Toronto. Below: R. A. Emerson, treasurer, George Dick, John Fox, president of A.P.E.O., M. A. Montgomery, Kitchener, and President McKillop.

Daylight Through The Mountain

The book, "Daylight through the Mountain" by Dr. Frank N. Walker, will be published shortly by the Engineering Institute.

This is the second extract, included in the *Journal* to interest engineers in the forthcoming book, which tells the remarkable story of Walter and Francis Shanly, two pioneer Canadian engineers.

Ed.

The Shanly brothers were always at their best when under pressure. The "Erie Railway" was increasing the speed by which it approached Lake Erie, but the owners of the Ogdensburg Railway were determined that their road should connect the Atlantic Ocean with the navigation of the Great Lakes first. The president, T. P. Chandler, of Boston, took Walter Shanly aside and told him that he was depending upon him and his brother Francis to push the work through on schedule. On May 5, 1850, Walter as Resident Engineer wrote to Francis:

"I am offering $1.25 for horses and carts, but my credit must be very low as not a single one will work for me. Quartz' are the only additional horses on the work. It is the first time I ever failed to get all I required to engage with me. I have despatched a messenger to Lower Canada to enlist Frenchmen, and will pay the duties on all the horses and carts he may bring with him. You must take care and not employ on our own work any of those ruffians who broke their engagements with me. I have strong faith in getting up a good gang of French Carters who will render us independent of those Irish Ruffians. I am equally in a fix for a foreman and after losing a week waiting for John Agent have been compelled to fall back on a damned Irishman. I shall require 3 or 4 more and will I suppose be driven to employing all the same sort. Angus McDonald is sulky and doing all he can to oppose my proceedings. He is determined not to put a night gang in the Thomas Cut and as the Cars all belong to C., W. & Co., I don't know what to do. The fellow is making a d--d fool of himself because he does his employers no good and he has applied to Mr. Chandler for a situation as a Freight Clerk. I will be obliged, very unwillingly, to cut off his head. I shall give him written orders to send down the Wheels, but if Abbott has given him a hint about the night work, he won't do it. The fact of the Cars being theirs gives them a certain hold on us and McDonald knows it, but the result of the opposition on the part of C., W. & Co. will be a total extinction of their contract.

"If that fool Worral was here, I could frighten him into giving orders, but McDonald sulks and I can get no good of him. I see no hopes of getting the track through here except by running through the Cut on a Grade of 80 feet to the mile. This I am resolved to do, sooner than not lay track before July. You must drive all you possibly can and where they fail to obey orders, *put on men*. See Section 10 be completed forthwith in every point. Raise the embankment by a grade of 26 feet in the mile to the level of the Piling. It will not do to let small things wait until the large are finished. Everything must go on at once.

"Chandler left on Saturday and gave me full power to do as I think best, only to push the work. I promised him I would and I will. He was very confidential with me towards the close of his visit, but I didn't ask for the $1,600. He would have ponied up right off. Could you save time at Freeman's by embanking from the West end also, taking material from the back of the Depot Ground? If this could be done, we might put a force into the East end of the Ridge and waste some excavation. Think over it and do whatever you can to let the engine go right on when I get her that far. Put a night gang in Hamblin and don't let John Roy sleep until he has got to the length of his tether with the embankment from the East.

"Touching the Culvert, I see no use in giving C., W. & Co. any more to do. So let Willard employ a gang to get out the covering and pier stone. Take off the Arch and Skeyback, but no more. Lay the Arch stones aside. They may be of use. Make a drawing of the Culvert as it is before pulling down.

"I will send by next mail Releases drawn up by Russell for Russell Worthen and Old Henderson. You can't survey until you get these, but do it as soon after as possible. Go out to Morley and see what Bridge lumber Barrett has sawn, also what 18 feet logs he has. I must come down upon him at once.

Yours as ever,
W. Shanly."

Elections and Transfers

At a meeting of Council held in Montreal, on May 10, 1957, a number of applications were presented for consideration and on the recommendation of the Admissions Committee, the following elections and transfers were effected:

Members: H. N. Black, Toronto, F. B. Bunting, Vancouver, R. F. Cole, Windsor, F. W. Cranston, Toronto, H. R. Davies, Toronto, O. Dorval, Ste. Foye, Que., W. Downs, Trinidad, D. A. Elliott, Calgary, M. E. Erfle, Calgary, G. H. Gallimore, Brockville, B. W. Gilbert, Montreal, J. I. Halporn, Montreal, H. D. Hamilton, Aurora, Ont., W. R. Hoffman, Port Hope, J. F. Howard, Peterborough, C. S. Kitchen, Hamilton, C. Lemesch, Montreal, J. T. Martin, Niagara Falls, V. Petrov, Montreal, H. D. Savage, Vancouver, D. Sawyer, Windsor, B. J. Seaman, Calgary, M. S. Thompson, Cornwall, G. A. Vissac, Montreal, W. White, Victoria, R. A. Yates, London, Ont.

Juniors: R. J. Bishop, Brownsburg, B. D. Blann, Hamilton, D. C. Burman, Toronto, L. A. Deschamps, Montreal, J. F. Fulton, Kingston, W. M. E. Kaye, Toronto, W. D. McDougall, St. John's, Nfld., R. R. Nicolet, Montreal, T. E. Pelton, Vancouver.

Junior to Member: D. E. Burnham, Cornwall, F. C. Creed, Ottawa, K. R. Fulton, Hamilton, J. Haworth, Cornwall, O. G. Hubley, Kentville, G. W. Joly, Montreal, A. E. Jones, Vancouver, E. Nenniger, Montreal, K. Piekarski, Toronto, T. M. Wardle, Victoria.

Student to Junior: H. Nahaiowski, Calgary.

Students Admitted:

University of New Brunswick: M. R. Cossitt, H. J. Fullarton, J. R. MacPhae, J. A. Parker.

Queen's University: W. R. Hough, N. L. Jeppesen, D. J. Wilson.

University of Alberta: N. M. Sokolowski.

Laval University: J. H. W. M. Chamberland.

Nova Scotia Technical College: R. J. Churchill.

Student A.P.E.O.: E. B. Logothetis, A. B. Frazer, P. J. Hoes, A. T. J. Wickins.

Graduates: A. R. Canzi, B.A.Sc. (Elec.), University of Toronto 1956.

Applications through Associations

By virtue of the co-operative agreements between the Institute and the Associations of Prefessional Engineers, the following elections and transfers have become effective:

ALBERTA

Members: M. A. Domecki, W. W. Laughlin.

Juniors: D. A. Hanenberg.

SASKATCHEWAN

Members: R. P. Couturier, E. F. Evoy, R. E. Melvin, G. F. Watts.

Juniors: J. Maandag.

Students: G. F. Blair, D. E. Cherry, J. D. Kilburn, H. Pelech.

Junior to Member: S. K. McMillan.

Student to Junior: J. A. Haynes, J. B. Street.

NOVA SCOTIA

Members: L. L. Centa, K. L. Farquharson.

Junior to Member: M. S. Boyd, A. B. Drew, R. J. Flinn, H. E. Reid.

NEW BRUNSWICK

Members: J. E. Callaghan, A. Sibson.

Junior to Member: T. Turgeon.

Student to Member: H. M. Keirstead.

E.I.C. Annual Meeting, 1958

Quebec City, Chateau Frontenac, May 21, 22, 23.

A Library Is For People

Shirley Courtis

Chief Librarian, Engineering Institute of Canada

Contrary to a belief held by certain people, a library is run for the benefit of its patrons, and not for that of the librarians! This applies particularly to the library of the Engineering Institute of Canada which is one of the best technical libraries in Canada. Its services are available to all members wherever they live, Vancouver or St. John, Labrador or London, the Yukon or Jamaica.

An engineer's studying days are not over the day he receives his degree, and many of the problems he has to tackle can be solved only through the resources of a technical library. The collection in the Institute library contains many thousands of books on all branches of engineering from a seventeenth century text on surveying to the latest on guided missiles and nuclear power plants. Five hundred different periodicals are received from all over the world, and in addition there are encyclopedias, dictionaries and all the reference books found in a general library, as well as five filing cabinets of pamphlets.

You may wonder how a member living out of Montreal can make use of the library facilities. The answer is, in many ways. Nearly all the books and magazines in the collection will be mailed on loan and the Institute pays the postage.

If you want a particular book or magazine article, a written request will send it on its way if it is in the library, and if it is not, it will be borrowed from another library, or a substitute sent. Librarians are also good at tracking down that book that you remember is about so big, and green, and something to do with . . . well, try and remember what it is to do with! The same applies to that magazine article that Joe told you he saw a year or so ago, in *The Engineering Journal*, or maybe it was in *Civil Engineering*, or maybe . . . anyway it would be just the thing.

If you are starting a new job, and would like to do some background reading, request a couple of general books on the subject. When you are coming to grips with a problem, write and explain the situation, and if there is a book or magazine article which will help, it will be sent to you. More complicated problems mean that a bibliography has to be compiled, listing all the books and articles available. It is important to give as many details about the problem as possible — it is very difficult to read between the lines, especially at a distance of a thousand miles or so!

Once you start research on a subject, try and compile a bibliography for yourself as you go along. Nearly all books and magazine articles contain lists of references, and some of them may provide just the information needed. Note down all the details given in the reference, as the omission of a volume number or part of the title may make the reference quite incomprehensible.

Students writing theses often request bibliographies on their topics, but the library cannot undertake to compile these, although books on the subject will be recommended. A very large staff would be needed to compile bibliographies for all the students writing theses each year!

Library Services

What else does the library do for you?

It provides a photostating service, at a very cheap rate. Through it you can subscribe to periodical publications of many other engineering societies at a reduced rate, and you can buy any technical book or pamphlet, at the ordinary retail price. New books are reviewed each month in *The Engineering Journal* and by reading these you can keep informed of the latest in your field.

If you are lucky enough to be within direct reach of either the Institute or another technical library, you can of course select your own material.

The first thing to do is to find your way around the library. Ask the librarian to show you how to use the card catalogue if it is a type with which you are not familiar, and how the numbers in the catalogue connect up with the way the books are arranged on the shelves. Find out where the periodicals are kept, and how to use the periodical indices. There are two of these which are important in a technical library, the Engineering Index and the Industrial Arts Index. Between them, they index by subject all the articles appearing in over twelve hundred technical periodicals — Did you realize there were that many — and more?

Take note of where the reference books and handbooks are kept. These will answer many questions from when was the first World Series, and who won it, to what is the length of the longest bridge in the world, and they are a good starting point when approaching a new subject. The latest information on any topic often appears in pamphlets — find out how the library keeps these, and do not be deterred by the term "vertical file". Usually it only means filing cabinet.

Professional Help

Familiarize yourself with the library regulations, and get to know the librarians — they can really be helpful. When you have a problem ask the librarian, maybe someone else was working on the same thing last week, or last year. She may remember, or have a note of it.

An engineer is a professional worker, and so is a fully-qualified librarian. She too has spent at least five years at university, because nobody can enter the one year course leading to the degree of Bachelor of Library Science without having at least a B.A. or a B.Sc. Although a librarian may have no previous knowledge of the subjects covered in her library, in this case engineering, this is not an unsurmountable difficulty. It is not actually knowing the answer which is important to a librarian, it is knowing *where* to find the answer that counts. As a result of her library school training, the librarian has this knowledge at her finger-tips.

If you are starting to work on a particular topic, begin by looking at the handbooks and textbooks, take note of the references they give, consult those, and then check the periodical indices and pamphlets for the latest articles.

Whether you are asking for information by mail, over the telephone, or across the desk, be as specific and informative as you can, a lot of your valuable time may be saved in the long run. Always ask for help if you need it, that is what librarians are for, and remember, the library is for people, and never let anyone tell you anything else.

Two prize winning pictures from the Engineering Institute Photographic Exhibit, 1956.

Above, Flight testing AVRO CF-100 interceptors.

Below, Fluid Catalytic Cracking Unit of Imperial Oil Limited, at Regina.

There's Life in The Old Dog

In the minds of many Canadians the daily newspaper, *The Times*, represents a serious matter-of-fact uncolorful daily publication. To one who has the opportunity to read *The Times* every day, the publication soon becomes almost a daily necessity. Throughout its long career it has been one of the outstanding publications in the world.

Just by way of proving that you can teach an old dog new tricks, the *Times* has come out recently with a publication called *Technology*. At the time of writing there have been just two issues. On its own masthead it describes itself as "The Monthly Review of Training and Education for Industry", and the publications so far issued certainly live up to that description.

Technology is filled with up-to-date news and observations on the very newest developments in the field of engineering and science. The articles are contributed by outstanding people in their field and are amplified by special short articles, letters to the editor and so on, which are both informative and entertaining.

It is a pleasure to welcome into the field of technical publication this new member. The Institute library has it so that members will have available to them in the reading room this very up-to-date and readable technical publication.

Science Bursary

A new educational grant, to be called the Elsie Gregory Magill Bursary after the first woman aeronautical engineer in Canada, has been established by the Toronto Business and Professional Women's Club.

The bursary will be a grant of $500 per year for five years for a girl secondary student who is interested in science. The recipient will study for four years at the University of Toronto and for one year at the Ontario College of Education. She will teach for a few years in Toronto secondary schools after graduation.

Miss MacGill, a member of the Engineering Institute, practises as a consulting engineer in Toronto.

Clement Matthew Anson

PRESIDENT

THE ENGINEERING INSTITUTE OF CANADA

1957

To fill the office of president this year the Engineering Institute of Canada has chosen a man reared in the steel industry, whose family has for two generations played an active role in its development.

Clement Matthew Anson, born at Rotherham, England, in 1901 is today vice-president and general manager of the Dominion Iron and Steel Limited; James Pender and Company Limited; and the Dominion Shipping Company Limited; all of which are subsidiary companies of the Dominion Steel and Coal Corporation Limited.

Mr. Anson's grandfather had built blast furnaces in India and the United States, as well as at home in England. His father, a steelmaker, and an open-hearth man, took part in the original development and production of raw steel for stainless steel products. He was one of the organizers of the Steelworkers Union of England, and eventually became a manager of a steelworks in Australia.

A child at the time his family left England, Clement Anson was within a few years absorbed in the family tradition. Familiar with the laboratory of the steel plant at fifteen, he assumed the duties of superintendent of a new steelmaking plant three years later.

In order to enroll in engineering at McGill University he left Australia at the age of twenty. He graduated with a bachelor of science in metallurgy in 1925.

From an initial position as a laborer with the blast furnace department of the Dominion Iron and Steel Limited, Sydney, N.S., at the time of his graduation, Mr. Anson has worked his way up in this primary Canadian industry. After a turn in the open hearth he served as a coke oven specialist, and in two years' time was assistant blast furnace superintendent. Successive appointments have been those of assistant superintendent of heavy mills, assistant general superintendent, and assistant general manager. In 1940 these promotions culminated in his appointment as general manager of Dominion Iron and Steel Limited, and subsequently his responsibilities were enlarged to include Seabord, Dominion Limestone, Pender, and Dominion Shipping. He took office as vice-president and general manager of Dominion Iron and Steel Limited in 1952.

In his capacity as general manager Mr. Anson's responsibilities cover not only the basic steel making and steel fabricating operations of the huge Sydney plant, but also include limestone quarrying at Agauthuna or Port-au-Port, Nfld; the manufacture of wire and nails at James Pender and Company, (Limited) Saint John, N.B.; the vast power generating and distributing network carried on by the Seabord Power Corporation Limited, Cape Breton, and the shipping operations of Dominion Shipping Limited.

A member of the Canadian Institute of Mining and Metallurgy, the British Iron and Steel Institute and the American Iron and Steel Institute, some of his other professional activities include membership in the board of governors of the Research Council of Nova Scotia and of the Nova Scotia Centre for Geological Sciences. For six years he was a member of the Board of Governors of the Nova Scotia Technical College.

His active participation in the affairs of the Institute dates to 1931, when he became an Associate Member. Mr. Anson transferred to Member in 1941, and later carried out the duties of vice-president of the maritime zone for the term 1946-47.

In 1950 he became the first engineer in the steel industry to enjoy the honour of receiving the two coveted awards of the Engineering Institute, the Julian C. Smith Medal, presented to him in 1950, and the Leonard Medal in 1954.

He is actively associated with many Sydney community enterprises. He is president of the Protestant Home for Aged People.

Mr. Anson is married to the former Dorothy Elizabeth O'Neil; they have two children, a son and a daughter.

Newly Elected Officers of the Institute

At the Annual Meeting, three vice-presidents and thirty-three councillors will take office, and will serve with others whose terms of office continue. The complete list of Council appears in this issue.

E. A. Leja, M.E.I.C., managing director of Lundrigan's Concrete Limited at Corner Brook, Newfoundland, has been elected councillor of the Institute, representing the Newfoundland Branch of the Institute for a two-year period.

A native of Latvia, Mr. Leja graduated from the University of Latvia at Riga in 1930 with a degree in chemical engineering. He immediately undertook the work of assistant superintendent of the finishing department with a glass manufacturing concern in Latvia. Appointed a lecturer at the Institute of Commerce in Riga, in 1932, he was within the next few years named a professor and lectured on the subject of the technological processes in the manufacturing of merchandise. In 1936 he left the University and assumed the duties of engineer in charge of extension with an asbestos-cement works at Riga. In 1937 he was made superintendent of the plant. From 1938, through the war years, he held various positions in Latvia as technical manager and managing director, one of which was a United Building Material and Portland Cement Works at Riga. Moving to West Germany in 1944 he again held similar positions until 1950.

E. A. Leja, M.E.I.C.

Upon his arrival in Canada in 1950 he took over the responsibility of chief engineer in charge of the construction of a cement plant and the gypsum and wallboard plant at Corner Brook for the Province of Newfoundland.

Managing director of the North Star Cement Ltd., and the Atlantic Gypsum Limited in 1951, he severed his connections with the latter concern in 1955 to take over the post he now holds with Lundrigan's Concrete Limited.

W. Watson, M.E.I.C.

W. S. Veale, M.E.I.C.

W. S. Veale, M.E.I.C., who has been elected councillor representing the Prince Edward Island Branch, is a native of that province. He attended Acadia University and graduated from the Nova Scotia Technical College in 1950 with a B.Eng. degree in civil engineering.

With the Canadian Army during the last three years of the war he served with the Intelligence Corps in Australia, the Phillipines, and Japan.

Mr. Veale is employed with the Federal Department of Public Works, harbours and rivers engineering branch, at Charlottetown, P.E.I.

He joined the Institute in 1950 as a Student Member and was transferred to Member in 1951.

William Watson, M.E.I.C., of the Canadian General Electric Company, St. John's, Newfoundland has been elected to represent the Institute as councillor for a two-year period.

Educated at Bishop Field College, Mount Allison Academy and Mt. Allison University he moved on to McGill University for the completion of his engineering studies and graduated in 1924 with the degree of B.Sc. in electrical engineering.

For the first two years of his career Mr. Watson served the Sir W. G. Armstrong Whitworth Company Limited as an assistant electrical engineer on the construction of a hydro-electric power station at Deer Lake, Newfoundland, now operated by the Bowater Power Company. He then joined the General Electric Company at Schenectady, N.Y., and embarked on the Test Course. Returning to Newfoundland in 1927 he opened an engineering sales and service office for the International General Electric Company in St. John's and continued as manager until Newfoundland confederated with Canada in 1949. At

W. A. Devereaux, M.E.I.C.

S. B. Cassidy, M.E.I.C.

that time he transferred to the Canadian General Electric Company Limited to organize and manage a new branch office and warehouse in the tenth province.

Mr. Watson was chairman of the Newfoundland Branch of the Institute for the term 1954-55. His membership dates from 1951. He is also an executive member of the Association of Professional Engineers of Newfoundland.

W. A. Devereaux, M.E.I.C., newly-elected councillor of the Institute, representing the Halifax Branch was chairman of the Branch in 1955 and has also held office on the executive.

Mr. Devereaux, who was born at Georgetown, Ontario, enrolled in the mechanical engineering course at the University of Toronto in the early thirties. Graduating in 1937 with a B.A.Sc. he went to Cleveland, Ohio, to attend the Bailey Meter Company Limited cadet engineering course. He returned to Canada a year later and spent a twelve month period at the head office of the company in Montreal before being transferred to Winnipeg. Carrying out service and sales engineering work in Western Canada he became in 1941 their first resident engineer in Vancouver. However, the following year he was recalled to Montreal in connection with defence project work for the Navy and Air Force on the East Coast and in Newfoundland.

In 1945 he opened the Halifax branch office of Bailey Meter Company Limited and was appointed its first manager, a position which he has held since then. This office handles all sales and service engineering for the company in the Atlantic provinces.

Mr. Devereaux is also affiliated with the Association of Professional Engineers of Nova Scotia, and was a member of council for two years. He served on the Association's examining board and the committee on professional relations.

He is a member of the American Society of Mechanical Engineers and the American Water Works Association, Maritime Branch.

He was the first chairman of the Halifax Branch E.I.C., committee on professional development in 1952.

Mr. Devereaux joined the Institute as a Member in 1946.

Stanley B. Cassidy, M.E.I.C., communications and electrical contractor of Fredericton, N.B., has been elected councillor to represent the Fredericton Branch of the Institute for a two-year term.

A native of New Brunswick, born at Sussex, he had his education in the province and graduated from the University of New Brunswick in electrical engineering in 1933 with a B.Sc. degree. Six years later he was awarded an M.Sc. degree in communications from the same university.

From 1933 to 1939 he was engaged in geophysical work with the New Brunswick Gas and Oil Field and was then appointed chief engineer with Radio Station C.F.N.B. He held this appointment until 1946 at which time he began the communications and electrical contracting work in which he is still engaged.

Apart from his engineering work Mr. Cassidy owns a restaurant, a hardware and a service station.

He joined the Institute in 1936 as a Junior Member and transferred to Member in 1943.

A. G. Watt, M.E.I.C., vice-president and general manager of the structural steel and warehouse divisions of the Consolidated Steel Corporation Limited, Saint John, N.B., will serve the council of the Institute representing the Saint John Branch for a second term.

A native of Scotland Mr. Watt came to Canada in 1927 and joined Canadian Vickers Limited in Montreal as a structural draughtsman. In 1929 he went to Saint John, N.B. and was chief draughtsman with the Saint John Drydock and Shipbuilding Company Limited for eleven years, and personnel manager for an additional two years.

He joined Foundation Maritime Limited in 1942 at Pictou, N.S. as a personnel manager. He was industrial relations and personnel director of Ferguson Industries of Pictou from 1943 to 1945 and then returned to Saint John Drydock and Shipbuilding Company Limited as chief draughtsman of the structural steel division, becoming chief engineer in 1950. He joined the Consolidated Steel Corporation in 1954.

Mr. Watt is an active member of the Saint John Branch and was its chairman in 1953. He joined the Institute in 1946.

Arthur G. Baxter, M.E.I.C., of Amherst, N.S., chief engineer with the Enterprise Foundry Company Limited at Sackville, N.B., in charge of the heating engineering department of the firm, has been elected to serve the council of the Institute for a two year term.

Born at Amherst, and educated there, Mr. Baxter qualified for an engineering certificate in 1916.

Beginning his career as a draughtsman and rodman at Wabana Mines, Wabana, Nfld., for the Nova Scotia Steel and Coal Company in 1916, he joined the Canadian National Railways at Quebec City in 1919 and remained there for two years. During the twenties he became shop engineer with the company.

In 1929 he joined the Anglo Canadian Pulp and Paper Company at Quebec City and held this position until 1931. At the end of the depression years he became engaged as an engineer salesman in the firm with which he is still associated.

Mr. Baxter joined the Institute in 1948.

Albert Deschamps, M.E.I.C., president of Deschamps and Belanger Limited, Montreal consulting engineers has been elected vice-president of the Institute

A. G. Watt, M.E.I.C.

representing the province of Quebec, or zone 'C' of the Institute.

Born in the United States, at Brockton, Mass., Mr. Deschamps studied engineering in Montreal and graduated from McGill University in architecture in 1916. Superintendent of construction with Atlas Construction Company at Montreal from 1914 to 1918, and later general superintendent with Bate McMahon Company in Ottawa, he has since 1922 engaged in contracting and engineering consulting work. Associated with an extensive program carried out for the Department of Munitions and Supply in Europe during World War II, in connection with the building of airfields and installations, he was in 1946 awarded the O.B.E.

He was named representative of industry on the National Advisory Council of Man-Power in 1951. The following year he was appointed to supervise Canadian interests in defence construction in Europe by the Department of Defence Construction.

Mr. Deschamps is a past-president of the Canadian Construction Association.

He joined the Institute in 1945 and previously served as treasurer of the E.I.C., in 1950.

R. B. Winsor, M.E.I.C., general manager of the Canadian Industries Limited, textile fibres division, at Montreal, will hold office as a councillor of the Institute representing the Montreal Branch for a three-year term.

Born in Newfoundland, Mr. Winsor had his early education there and later attended Mount Allison University and McGill University. He was graduated from McGill with a B.Sc. degree in civil engineering in 1927, and that year went to work as construction engineer with W. I. Bishop Limited, on pulp and paper mills in Quebec. The following year he returned to Newfoundland to work for Newfoundland International Paper Company, at Corner Brook, as a design engineer.

In 1930, again resident in Quebec, he joined Canadian Industries Limited, beginning his lengthy career with the company. Project engineer at that time, he was two years later promoted to assistant works manager at Shawinigan Falls, and later works manager, also at that location.

With the onset of World War II, named construction manager of Defence Industries Limited, Montreal, he was, through the early forties, successively works manager, and manager of D.I.L. small arms ammunition division at Montreal. Named construction manager in the D.I.L. atomic energy project at the close of hostilities he was in 1946 appointed general manager of Canadian Titanium Pigments Limited. The following year he was named production manager with the Canadian Industries Limited chemicals division. In 1949 he became assistant general manager of the division, and three years later chief engineer. His present position dates from 1954.

Mr. Winsor is vice-president and director of the Canadian Fabrics Foundation and director of the Silk and Rayon Institute of Canada.

He joined the Institute as a Member in 1952.

L. P. Dancose, M.E.I.C., engineer and superintendent of the Canada and Gulf Terminal Railway Company, at Mont Joli, Que., has been elected a councillor of the Institute to represent the Lower St. Lawrence district.

Born at St. Evariste, Frontenac County, Que., Mr. Dancose received his education at Laval University and at the Ecole Polytechnique. On graduation employed with the Canadian National Railway, Levis division, for the first five years, he was then promoted to assistant division engineer at Quebec, serving the Laurentian division. Early in 1948 he joined the Canada and Gulf Terminal Railway Company as an engineer and superintendent, and, at the end of that year was promoted to superintendent.

R. B. Winsor, M.E.I.C.

Active in the Lower St. Lawrence Branch since its inauguration in 1952 he was appointed its first councillor, and has held this office consecutively since that time.

Mr. Dancose joined the Institute as a Student in 1942. He became a Junior Member in 1946 and in 1951 transferred to Member.

G. J. Cote, M.E.I.C., dean of engineering at the University of Sherbrooke, has again been elected to the council of the Institute to represent the Eastern Townships Branch of the Institute. He previously held office in 1953-54, 1955-56.

Mr. Cote was born at Sherbrooke, obtained his education at the St. Jean Baptiste Academy, St. Louis College, and the Ecole Polytechnique. He was awarded a B.A.Sc. in civil engineering in 1936.

Before his graduation engaged in survey work he immediately afterwards joined the firm of Crepeau and Cote and was a junior partner until 1940, supervising bridge construction and municipal projects. With the outbreak of World War II, Mr. Cote joined the Royal Canadian Engineers in 1940 and served overseas.

Beginning on a post-war career, he was on his return appointed senior associate member of the firm of Crepeau and Cote, which was later to be renamed Cote, Lemieux, Carignan and Bourque.

He joined the Institute in 1946.

He is member of the Corporation of Professional Engineers of the Province of Quebec.

Archibald B. Sinclair, M.E.I.C., superintendent of the hydro-electric department of Price Brothers and Company at Kenogami, Que., has been elected councillor representing the Saguenay Branch of the Institute for a two-year term.

Born at Truro, N.S., and educated in Western Canada, he received a B.Sc. degree in electrical engineering from the University of Manitoba in 1927. In his

A. Deschamps, M.E.I.C.

G. J. Cote, M.E.I.C.

first graduate year associated with the Canadian Westinghouse Company at Hamilton, Ont., as a student, he was in 1928 appointed assistant to the general superintendent with Price Brothers and Company Limited. Three years later he became chief operator with the Kenogami Substation of Price Brothers and Company Limited, and held that position for some time.

With the Canadian Army directorate of artillery at Ottawa, during World War II, he was engaged in the design and production of radar equipment for the allied service.

Retiring from the army with the rank of major in 1946 he returned to the firm of Price Brothers at Kenogami and accepted the position of general superintendent of the hydro-electric department of the firm.

Mr. Sinclair joined the Institute in 1927 as a Student Member, transferred to Junior in 1928 and to Associate Member in 1935. He became a Member in 1940.

A. B. Sinclair, M.E.I.C.

E. D. Gray-Donald, M.E.I.C.

E. D. Gray-Donald, M.E.I.C., past-chairman of the Montreal Branch of the Institute, has been elected a councillor of the Institute to represent that branch for a three-year term. Mr. Gray-Donald was previously chosen for this office in 1953, and earlier in 1942 and 1948 served the Quebec Branch. He was chairman of the Quebec Branch in 1944-45.

He is the vice-president of personnel and public relations with the Shawinigan Water and Power Company, Montreal; also vice-president and director of the Quebec Power Company, Quebec City, and a director of the Montreal City and District Savings Bank.

Born in Amoy, China, he followed his early studies at Victoria, B.C., and in Edinburgh. He returned to Canada in 1921 after spending two years in Palestine on general engineering work, and enrolled at McGill University where he obtained a B.Sc. in electrical engineering in 1926. He carried on post-graduate studies at Laval University, and obtained the degree of M.Sc. in 1934.

He joined the Shawinigan Water and Power Company in 1926 and followed the company apprenticeship course, being transferred to the Quebec Power Company in 1927. Filling various positions through the next few years he was appointed general superintendent in 1937 of the Quebec Power Company and the Quebec Railway, Light and Power Company. In 1942 he was appointed chief engineer for both companies, and was named vice-president and chief engineer of the Shawinigan Water and Power Company in 1950. His present position was announced in 1954.

Mr. Gray-Donald is a member of the Institution of Electrical Engineers; the American Institute of Electrical Engineers; the Society of Automotive Engineers; the Corporation of Professional Engineers of Quebec and the Canadian Electrical Association. He was appointed to the executive committee of the Canadian Transit Association in 1941, and was elected president 1946-48. He was vice-president of the Canadian Electrical Association in 1947-49, and president in 1949-50.

From 1940 to 1950 he was actively engaged in the work of the Reserve Army, and at retirement held the rank of lieutenant-colonel in the Royal Canadian Electrical and Mechanical Engineers.

Mr. Gray-Donald joined the Institute as a Student Member in 1922, transferred to Junior in 1926 and to Associate Member in 1934. He became a Member in 1939.

J. H. Budden, M.E.I.C., assistant superintendent of switching systems engineering with the Northern Electric Company Limited has been elected a councillor to represent the Montreal Branch of the Institute for a three-year term.

Born in Surrey, England, Mr. Budden attended Wellington College, England, and completed his studies in Canada at McGill University, graduating with a B.Eng. degree in electrical engineering in 1937. Later he attended a General Electric Company post-graduate test course at Witton Works, Birmingham.

On active service with the Royal Canadian Corps of Signals in Canada, England and Italy in World War II, he spent the greater part of the time with the Fifth Canadian Armoured Division.

Early in 1945 joining the Northern Electric Company Limited as a telephone equipment engineer he became, three years later, an engineering supervisor and was promoted to his present post in 1952.

Mr. Budden joined the Institute as a Student Member in 1936 and transferred to Member in 1946.

Very active in the work of the Institute, he served on the Montreal Branch membership committee in 1951 and also held the office of committee chairman at that time. A member of the executive committee in 1952 and chairman of the admissions committee in 1953, he worked on the Nominating Committee from 1954 to 1956.

Mr. Budden has been a member of the Corporation of Professional Engineers since 1946.

Walter G. Seline, M.E.I.C., of Trois Rivieres, Que., manager of the Quebec manufacturing division of the Packard Electric Company Limited, will carry out the duties of councillor for the St. Maurice Valley Branch.

Born in Finland and educated in Winnipeg, Mr. Seline graduated from the University of Manitoba in electrical engineering in 1945. On staff at the University the following year, he joined the Shawinigan Water and Power Company at Shawinigan Falls, Que., in 1947. From 1948 until his appointment to his present post in 1956, he was design engineer in Shawinigan's electrical repair department at Trois Rivieres.

Active in the affairs of the Engineering Institute he has served as chairman of

J. H. Budden, M.E.I.C.

the junior section of the Institute in St. Maurice Valley and as a member of the Branch executive.

Mr. Seline is a member of the Corporation of Professional Engineers of the Province of Quebec, and the American Institute of Electrical Engineers.

He is secretary-treasurer and vice-chairman of the section of the American Institute of Electrical Engineers, and a member of the Committee on Unity for the Corporation of Professional Engineers of Quebec.

Mr. Seline joined the Institute in 1944. A Student Member at that time, he became a Junior in 1947 and was transferred to Member in 1951.

W. J. Ripley, M.E.I.C., of Sudbury, Ont., has been chosen a vice-president of the Institute representing the province of Ontario. Now economic consultant for Pineland Timber Company Limited, Sudbury, and vice-president of the firm for Ontario, he was for twenty-eight years associated with the International Nickel Company of Canada Limited at Copper Cliff, Ont.

Mr. Ripley attended Mount Allison University for the first part of his engineering training and graduated from McGill University in 1914 with a degree in civil engineering. He was born in Nappan, N.S.

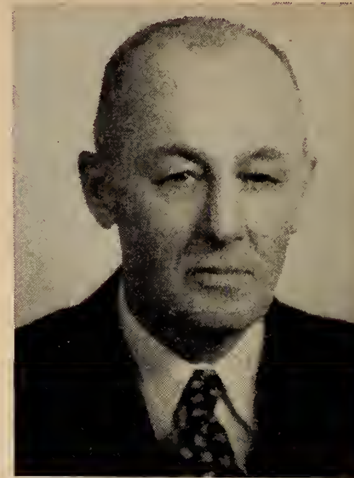
He gained his early professional experience with the Canadian National Railways as a transitman. Later he worked for the Koppers Company at Sydney, N.S. and with the Dominion Coal Company at Glace Bay, N.S. during the twenties.

He first became associated with the International Nickel Company in 1928 at Copper Cliff, Ont., first as a designing draughtsman, later as a master mechanic of reduction plants, in charge of all mechanical maintenance and has done considerable construction for reduction plants. He retired in 1956.

Mr. Ripley is a past chairman of the Sudbury Branch and was a committee member of the Sault Ste. Marie Branch.

He joined the Institute in Cape Breton in 1923 as an Associate Member and was transferred to Member in 1926.

G. E. Humphries, M.E.I.C.



W. J. Ripley, M.E.I.C.

George E. Humphries, M.B.E., M.E.I.C. vice-president and general manager of M. M. Dillon and Company Limited, and director of Allied Consultants of Canada Limited has been elected councillor to represent the London Branch of the Institute for a two-year term of office.

Born in England, he was educated at Wolverhampton and Staffordshire Technical College. He received a national certificate in mechanical engineering from the Institution of Mechanical Engineers in 1927. The following year he came to Canada and worked with the Hamilton Bridge Company and in 1929 became engaged in structural design for the Hydro-Electric Power Commission of Ontario. Later he worked for a time with McClintic Marshall Construction in Pittsburgh. With the Department of Lands and Forests in the early thirties he was for several years afterwards employed in the mining industry. From 1935 to 1940 he was associated with the Canadian Comstock Company Limited at Toronto, working on the design and construction of the metallurgical and power plants in mines in Ontario.

Overseas with the Royal Canadian Engineers in World War II he has since that time engaged in private practice in the firm with which he is now associated.

He previously served the Institute as chairman of the London Branch in 1951.

He joined the Institute in 1930 as a Junior Member and was transferred to Member in 1943.

F. A. Orange, M.E.I.C., of Sudbury, Ont., has been elected to the council of the Institute representing the Sudbury Branch. This follows previous E.I.C. service including that of branch chairman in 1954-55. He was also a charter member of the Branch on its formation in 1950.

A mechanical design engineer with the International Nickel Company, Mr. Orange was born in the United States, but has been a resident of the Ontario city most of his life. He had his early education in Sudbury and later attended Queen's University, graduating with a B.Sc. degree in mechanical engineering in 1927.

His initial experience gained with the Carborundum Company at Niagara Falls, N.Y., he began his career with the International Nickel Company in 1931. He has been connected with the mechanical and construction department since that time. During World War II and until 1947, he served with the Royal Canadian Engineers. During the latter part of this term he was posted to the directorate of engineer research and development at National Defence Headquarters in Ottawa.

He is a member of the Association of Professional Engineers of Ontario.

Mr. Orange joined the Institute in

W. G. Seline, M.E.I.C.

F. A. Orange, M.E.I.C.

1927 as a Student Member, became an Associate Member in 1934, and a Member in 1940.

Peter S. Dewar, M.E.I.C., chief maintenance engineer with the Ford Motor Company at Windsor, Ont., has been elected councillor to represent the Border Cities Branch of the Institute.

Mr. Dewar was born at Windsor, Ont. He attended the University of Toronto and graduated with a B.A.Sc. degree in 1943. Employed as a student with the Ford Motor Company during the summer months he later joined the company as a designing engineer in foundry design, on graduation. He was promoted to assistant engineer of foundry design in 1949, and of mechanical design, mechanical engineering division, the following year.

Mr. Dewar joined the Institute in 1944 as a Junior member and transferred to Member in 1951. He served as secretary-treasurer of the Border Cities Branch in 1953.

Ralph Choate Wilson, M.E.I.C., publisher of the *Evening Guide* at Port Hope, Ont., will represent the Port Hope Branch of the Institute as Councillor for a two-year term.

Mr. Wilson is a native of the city in which he now lives and is a graduate of the University of Toronto in mechanical engineering, class of 1927.

He is associated with the firm of George Wilson and Son, Port Hope, Ont.

He joined the Institute as a Member in 1952.

John Stanley Waddington, M.E.I.C., chief engineer of Phillips Electrical Company Limited, has been elected a councillor representing the Brockville Branch of the Institute.

Mr. Waddington was born in Winnipeg. He received his B.Sc. degree in electrical engineering from the University of Manitoba in 1934, and the following year joined the Canadian Marconi Company in Montreal.

He entered the Phillips Electrical Works Limited in 1936 and was associated with the company's manufacturing department in Brockville and Montreal until 1938 when he was appointed technical secretary to the president in Brockville. In 1944 he entered the engineering department and three years later was named chief engineer.

He is a member of the American Institute of Electrical Engineers; the Canadian Standards Association and a member of several technical committees of C.S.A. and C.E.M.A. He is chairman of the Canadian Electrical Manufacturers Association Wire and Cable Division technical committee, and a former member of the Committee on the Canadian Electrical Code Part I.

He joined the Institute in 1947 with the status of Member. He was chairman of the Brockville Branch in 1954.

W. B. Pennock, M.E.I.C., president of the firm of Pennock Canadian-British Limited, consulting engineers, Ottawa, has been elected to represent the Ottawa branch of the Institute as a councillor.

Mr. Pennock is a native of Ottawa and a graduate of McGill University. He was awarded a B.Sc. degree in 1915. He went overseas with the Canadian Engineers, Canadian Expeditionary Force, immediately on graduation. At war's end, returning to Canada, he was for two years District Vocational Officer in the Department of Soldier's Civil Re-establishment.

In 1920 he accepted a position with the Gray-Dart Motor Car Company as an agent and field representative. Four years later he was named department manager with the Canadian Fairbanks Morse Company at Windsor, Ont., and in 1925 set up a manufacturing agency and engineering contractor practice in Windsor, London and Hamilton. After ten years he joined the Department of National Defence, Ottawa, as chief mechanical engineer. He later returned to his business as sales engineer, acting for a number of manufacturers.

The second world war entailing further military service Mr. Pennock was, during the years 1940-45, second in command of the engineering training centre, and later C.R.E., 8th Canadian Division, in Western Canada, which appointment carried the rank of lieutenant colonel.

On demobilization he became re-established as sales engineer in operating his own business, and continued under this arrangement until 1949 when Pennock Engineering Company was established as a consulting engineering firm, associated with Canadian-British Engineering Consultants, in Toronto, Halifax and Vancouver.

The firm Pennock Canadian-British Limited was formed in January 1957.

J. S. Waddington, M.E.I.C.

Mr. Pennock served as chairman of the Ottawa Branch of the Institute in 1956. His association with the Institute dates from 1919 when he was a Student Member. He became an Associate Member in 1936 and transferred to Member in 1940.

K. F. Tupper, M.E.I.C., has been chosen to represent the Toronto Branch of the Institute for a three year term as councillor. He is the president of Ewbank and Partners (Canada) Limited, at Toronto, a firm engaged in the engineering design of thermal power stations.

Mr. Tupper was born in the United States and had his early education in Western Canada. He graduated from the University of Toronto in 1929 with a B.A.Sc. degree in mechanical engineering. Later he obtained an M.Sc. degree in aeronautical engineering in 1938. On receiving his bachelor's degree in 1929 he joined the staff of the Riverside Iron Works Limited, Calgary, as a draughtsman, and later that year accepted a position with the National Research Council, Ottawa, where he was engaged

K. F. Tupper, M.E.I.C.

W. B. Pennock, M.E.I.C.

in the design and operation of aeronautical research equipment. In 1943 he was appointed Member of the Canadian team to report on aircraft gas turbine developments in Britain. Merging from this work, a company called Turbo Research Limited was formed, which was a forerunner of the Aircraft Gas Turbine Division of A. V. Roe Canada Limited at Malton. It subsequently became Orenda Engines Limited. In 1946 when this project passed from Turbo Research to A. V. Roe, Mr. Tupper returned to the National Research Council and joined the atomic energy project of Chalk River. In 1947 he was appointed director, with the engineering division of the project.

Mr. Tupper became the fifth dean of the faculty of applied science and engineering at the University of Toronto in 1949. However, he retired from this post in 1954 to join the firm in which he is now president.

In 1947 Mr. Tupper was awarded the O.B.E. in recognition of his wartime services.

He has been a Member of the Institute since 1949.

C. H. R. Campling, M.E.I.C.

S. Sillitoe, M.E.I.C.

Sydney Sillitoe, M.E.I.C., who previously served on the council of the Institute, representing the Belleville Branch from 1953 to 1956, has been re-elected for his third term.

A Westerner, from Edmonton, he had his engineering training at the University of Alberta and was graduated with a B.Sc. degree in 1931. For an additional two years he studied communication and structural design and in 1933 received an M.Sc. degree. He later undertook post-graduate research work at McGill University.

Now production superintendent of the Northern Electric Company Limited communications equipment division, Belleville, Ont., he became associated with the company in 1934 in Montreal as a junior engineer. Ten years later named technical engineer in charge of production engineering he was promoted to broadcast equipment design engineer in 1946. The following year he became an equipment engineer at the Belleville plant and in 1950 received the appointment of assistant superintendent of general assembly.

During World War II he was assigned to the Department of Munitions and Supply on a technical mission to England in 1941.

Mr. Sillitoe is a member of the Association of Professional Engineers of Ontario and an associate member of the Institute of Radio Engineers.

He is a charter member of the Montreal section of I.R.E., having served as its secretary in 1937-38 and its chairman in 1938-39. He has been associated with the work of the Canadian Radio Technical Planning Board, and of the Radio Manufacturers Association of Canada. He has also served on the rehabilitation advisory committee of the school of electronics at Ryerson Institute.

When the Belleville Branch of the Institute was formed in 1950 Mr. Sillitoe was elected secretary and was in 1952 the first elected councillor.

He joined the Institute in 1930 as a Student, was transferred to Junior Member in 1936 and became a Member in 1943.

R. R. Prescott, M.E.I.C.

C. H. R. Campling, M.E.I.C., associate professor, department of electrical engineering at Queen's University, Kingston, Ont., has been elected to represent the Kingston Branch of the Institute as councillor for a two-year period.

A native of Melville, Sask., Mr. Campling attended Melville Public School and Queen's University where he received a B.Sc. degree in electrical engineering in 1944.

During 1944 and 1945 Mr. Campling served with the Royal Canadian Signals and at war's end was named an instructor in the department of mathematics at Queen's University. Appointed research engineer in 1948 in the servo-mechanisms laboratory of the Massachusetts Institute of Technology he also at that time received the S.M. degree.

During the following year he was engaged in research work in the field of magnetic amplifiers with the National Research Council. It was in 1950 that he became assistant professor at the Royal Military College. He was responsible for the installation of the electrical power laboratory and the organization and teaching of courses on the power aspects of electrical engineering. He has held his present position since 1955.

Professor Campling is an associate member of the American Institute of Electrical Engineers and a member of the Institute of Radio Engineers, and the Association of Professional Engineers of Ontario.

Active in the affairs of the Institute he served on the executive of the Kingston Branch in 1952 and 1953, as vice-chairman in 1953-54, and as chairman the following electoral term. He is also the E.I.C. representative on the committee on Education and Accreditation of the Engineers' Council for Professional Development.

He became a Student member of the Institute in 1943.

R. R. Prescott, M.E.I.C., electrical superintendent of the Canadian International Paper Company's Kipawa mill at Temiskaming, Que., has been elected a councillor of the Institute, representing the Nipissing and Upper Ottawa Branch of the Institute.

Born at Walton, N.S., he attended Acadia University and obtained a certificate in applied science, later graduating from the Nova Scotia Technical College with a B.Sc. degree in electrical engineering in 1932.

Toward the end of the depression years he obtained a post as chief operator at the St. Anthony Gold Mines, power plant, at Savant Lake, Ont., in 1936, and after two years was promoted to chief electrician.

He joined the Canadian International Paper Company at Dalhousie, N.B. as an electrical engineer in 1940. Seven years later he was transferred to the C.I.P. Gatineau Quebec mill as an assistant electrical superintendent, and in 1951 was moved to the Kipawa mill at Temiskaming where he held the same position. His promotion to electrical superintendent dates to 1954.

Mr. Prescott joined the Institute as a member in 1948. He was a charter member of the Nipissing and Upper Ottawa Branch of the E.I.C. on its formation in 1952. He has served the Branch executive since that time and was the 1956 choice as chairman of the group.

E. T. Charnock, M.E.I.C., superintendent of technical services of the Great Lakes Paper Company, Fort William, Ont., will be a member of the Council representing the Lakehead Branch of the Institute.

Associated with that company since 1942, he was at first employed in the capacity of sulphite engineer and was later named assistant sulphite superintendent. Three years ago he assumed the position he now holds.

Mr. Charnock is a native of Fort William and a 1938 graduate of the University of Toronto with a B.A.Sc. degree in chemical engineering. He worked at that time with the J. R. Walkings Company as a chemist at Winnipeg.

He was elected chairman of the Lakehead Branch in 1955. Mr. Charnock's association with the Institute dates to 1944 when he joined as a Junior Member. He transferred to Member in 1948.

S. C. Montgomery, M.E.I.C., has been elected to represent the Western Provinces as vice-president for two years. He is a maintenance engineer with the Consolidated Mining and Smelting Company at Trail, B.C., smelting and refining division.

Mr. Montgomery was born in Winnipeg, Man., and attended public and high schools there. Commencing his university studies at the University of Manitoba he transferred a year later to McGill University graduating with a B.Sc. in mechanical engineering in 1915.

Enlisting in the Canadian Field Artillery in 1915 he joined the First Brigade, Canadian Field Artillery, First Division in France. He later transferred to the Fifth Brigade, Second Division, and served until 1919. He was awarded the Military Cross and also received mention in despatches. After a refresher course at the Royal Technical College, Glasgow, he returned to Canada late in 1919.

Re-established in this country he began the next phase of his engineering career as a designing draughtsman with the Whalen Pulp and Paper Company in British Columbia, worked in the logging industry on Vancouver Island and in 1925 became assistant superintendent of construction and maintenance.

In 1929 he joined the Consolidated Mining and Smelting Company at Trail,

E. T. Charnock, M.E.I.C.

S. C. Montgomery, M.E.I.C.

again as a designing draughtsman and was shortly transferred to the duties of assistant construction engineer on the construction and maintenance of the Tadanac plants in 1929. During the depression years he held a variety of posts and in 1936 was named assistant construction engineer of the Tadanac plants. His present position of maintenance engineer, smelting and refining department dates to 1948.

Mr. Montgomery joined the Institute as a Student in 1911, became a Junior Member in 1920, transferred to Associate in 1929 and to Member in 1940. He is a charter member of the Kootenay Branch and was its first chairman and councillor.

J. L. Phelps, M.E.I.C., president of the Yukon Hydro Company Limited and a member of the firm of Phelps and Scott Engineering, consulting engineers, will represent the Yukon Branch of the Institute as councillor for a two-year term.

A native of the Yukon Mr. Phelps was born at Whitehorse and had his early education there, later attending Upper Canada College and the University of British Columbia. He graduated with a B.A.Sc. degree in 1940. Since then he has held positions as superintendent and secretary-treasurer of the Yukon Electrical Company from 1940 to 1950 and secretary-treasurer and managing director of the Yukon Hydro Company Limited in 1950-51. He became a partner in Phelps and Scott Engineering in 1949.

Mr. Phelps joined the Institute in 1951 as a Member. Secretary-treasurer of the Yukon Branch in 1953-54 he was in 1954-55 elected to fill the duties of chairman of the Branch.

He was also a member of the Yukon Council from 1952 to 1957.

W. D. Hurst, M.E.I.C., city engineer and commissioner of buildings, at Winnipeg, will represent the Winnipeg Branch on the council of the Institute for a two-year term.

A native of Manitoba, Mr. Hurst is a graduate from the University of Manitoba, class of 1930, in civil engineering. He received a C.E. degree in 1931, following graduate studies at the Virginia Polytechnic Institute while on a teaching fellowship.

Associated with the City of Winnipeg Engineering Department in 1930, he rejoined it in 1931 and began his career as a resident engineer on reservoir construction. Ultimately he became an investigating engineer, engineer in the water works branch and assistant city engineer. His present appointment dates from 1944.

He has been chairman of commissioners of the Greater Winnipeg Water District since 1949. Chairman of the Rivers and Streams Protection Authority since 1951 he has also been chairman of the Winnipeg Building Commiittee since 1944.

Mr. Hurst served as secretary-engineer on the Board of Engineers for the Greater Winnipeg Sanitary District from 1935-39, and was appointed commissioner of the Winnipeg-St. Boniface Harbour Commission in 1946.

In World War II he was captain and officer commanding the Engineers First Workshop and Park Company with the Tenth Reserve District Engineers of the R.C.E.

Mr. Hurst served the Association of Professional Engineers of Manitoba as its president in 1950 and 1951. A member of the American Water Works Association, he was chairman of the Minnesota section in 1947-48; and also chairman of the Canadian Section in 1952-53; he was a director from 1952 to 1955. He was elected a director of the American Public Works Association for the term 1956-58. He is also a member of the Canadian Institute of Sewage and Sanitation.

Mr. Hurst is a registered professional engineer in the province of Manitoba and in the state of Minnesota, and is registered as an architect in the province of Manitoba.

His professional service was recognized by the award of the George Warren Fuller Award of the American Water Works Association in 1946.

As to Institute affairs, Mr. Hurst was chairman of the Winnipeg Branch in 1938 and was again elected in 1951. Mr. Hurst joined the Institute as a Student Member in 1927. He transferred to Associate Member in 1935 and became a Member in 1940.

M. L. Wade, M.E.I.C., has been elected Councillor of the Institute, representing the Central British Columbia Branch for a two-year term of office following previous service from 1950.

He is a consulting engineer at Kamloops, practising in the electrical and hydraulic field and serving the interior of British Columbia and parts of Western Alberta.

Born in the United States, he came to Canada at an early age and had his education in this country. A 1912 graduate from McGill University in electrical engineering, he joined the staff of the Canadian Westinghouse Company and worked at Montreal, Hamilton and Winnipeg. For an additional two years located at Regina, Sask., he then moved west to British Columbia where he was employed with the Canadian General Electric Company at Vancouver as a service engineer.

During the next few years Mr. Wade worked with the East Kootenay Power Company as superintendent of generating stations, and was promoted to general superintendent the following year. In 1930 he was engaged by the West Kootenay Power and Light Company to carry out damsite investigation and superintend surveys in connection with the Adams River Canyon. This led to the establishment of Mr. Wade's present consulting practice.

He is a member of the Association of Professional Engineers of British Columbia and of the American Waterworks Association, Canadian Section.

M. L. Wade, M.E.I.C.

W. L. Sharpe, M.E.I.C.

Mr. Wade was active in the inauguration of the Central British Columbia Branch of the Institute in 1949, and was its first chairman. He joined the Institute as a Junior in 1914, transferring to Associate Member in 1917, and to Member in 1936.

W. L. Sharpe, M.E.I.C., city engineer for the City of Weyburn, Sask., has been elected to council for a two-year term, representing the Saskatchewan Branch of the Institute.

A native of Yorkton, Sask., he received his early education there, and then entered the College of Engineering at the University of Saskatchewan in 1931 where he studied for three years. During the Second World War, he served for five years as an officer in the Royal Canadian Artillery, second division, and on discharge returned to the University of Saskatchewan where he graduated in civil engineering in 1947. Mr. Sharpe then spent one year with the Saskatchewan Department of Highways as a resident engineer and in March 1948 accepted his present position in Weyburn.

W. D. Hurst, M.E.I.C.

R. N. McManus, M.E.I.C.

He is a member of the Association of Professional Engineers of Saskatchewan, serving as councillor for two consecutive terms in 1953-55.

Mr. Sharpe joined the Institute as a Junior member in 1948 and transferred to Member in 1950.

R. N. McManus, M.E.I.C., who has been elected to serve as councillor for the Edmonton Branch, is an associate professor of civil engineering at the University of Alberta. Also occupied with Institute affairs in another sphere, he is a member of the papers committee, for the annual meeting in June.

Professor McManus is a westerner by birth. Born at Lomond, Alta., he was a 1942 graduate of the University of Alberta in civil engineering. He was a member of the teaching staff of the department of civil engineering, from the time of his graduation until 1956. He obtained an M.Sc. degree in civil engineering in 1946 from the University of Alberta in the field of structures. In 1952 he obtained a Ph.D. degree in engineering from the University of Illinois in structural engineering.

His professional engineering experience has been related to his consulting practice conducted for nine years while a member of the university faculty. From 1952 to 1956 a principal in the consulting firm of Structural Engineering Services Limited, he was the resident principal at Edmonton. In this position he shared major professional responsibility for the design of such structures as Nisutlin Bay Bridge, North-West Highway System, Groat Bridge in Edmonton Chin Reservoir Crossing near Lethbridge, Sheep River Bridge near Okatoks major overhead crossings of the Peace and Fraser Rivers of the West Coast Transmission Gas Lines and many millions of dollars worth of specialty designs such as pre-stressed concrete bridges and buildings.

At present on leave of absence from the University until the beginning of th

1956 fall term, he is devoting full time to his consulting practice.

Mr. McManus is a member of the board of examiners of the Alberta Association of Professional Engineers, alternate representative on the Edmonton architectural panel and a member of the special committee on architect-engineer relationships. He also holds non-resident license in the Association of Professional Engineers of British Columbia. He was the chairman of the Edmonton Branch E.I.C. in 1956.

Mr. McManus joined the Institute as a Student Member in 1941, became a Junior in 1943 and transferred to Member in 1946.

Commander **P. F. Fairfull,** M.E.I.C., superintendent of the Graving Dock at Esquimalt, B.C., has been elected to represent the Vancouver Island Branch on the council of the Institute for a two-year term.

A native of Great Britain, Commander Fairfull began his engineering career as an apprentice with William Simons and Company Limited, engineers and shipbuilders at Renfrew, Scotland.

Established in this country in 1925, he accepted a position in Toronto with Chapman and Oxley, architects and engineers. In 1933 he went to work for the Toronto Star as development engineer but with the onset of the war, once more was connected with shipbuilding. He served as chief engineer for the Crown operated Toronto Shipbuilding Company which firm he joined in 1941. In the Naval Service two years later, he was appointed overseer of ship construction on the Great Lakes and later Principal Naval Overseer on the West Coast. He then became manager of the constructive department, H.M.C. Dockyard, Esquimalt, B.C., and still retains the rank of Constructor Commander, R.C.N., (R).

In 1948 the Department of Public Works of Canada named him superintendent of the Graving Dock at Esquimalt, B.C.

Commander Fairfull has been helpful to the Institute on many occasions since his election as a Member in 1949. He is the immediate past-chairman of the Vancouver Island Branch, and a former secretary-treasurer also.

Cdr. P. F. Fairfull, M.E.I.C.

W. O. Richmond, M.E.I.C., head of the department of mechanical engineering of the University of British Columbia has been elected a councillor to represent the Vancouver Branch of the Institute for a two-year term.

Professor Richmond was born in Rouleau, Sask., and obtained a B.A.Sc. degree in mechanical engineering from the University of British Columbia in 1929. In 1933 he was awarded an M.Sc. degree in mechanical engineering from the University of Pittsburgh.

W. O. Richmond, M.E.I.C.

On attaining his bachelor's degree he joined the Westinghouse Electric and Manufacturing Company in East Pittsburgh as a research engineer in the mechanics division. He remained there until 1934. During the next two years he was research assistant in the testing materials laboratory of the Massachusetts Institute of Technology and the following year became instructor in mechanics and materials at the Case School of applied science in Cleveland, Ohio.

He joined the mechanical engineering staff of the University of British Columbia in 1937 as an assistant professor of mechanical engineering, was named associate professor in 1943, and four years later received the appointment of professor of mechanical engineering. He has held the responsibilities of head of the mechanical engineering department since 1950.

He is a member of the American Society of Mechanical Engineers. His affiliation with the Association of Professional Engineers of British Columbia has resulted in his election as president for 1957.

He was the choice in 1954 of the Vancouver Branch of the Engineering Institute for chairman, after several years of work in Institute activities. He joined the Institute as a Member in 1950.

W. K. Gwyer, M.B.E., M.E.I.C., assistant manager of the engineering division of Consolidated Mining and Smelting Company of Canada Limited in Trail, B.C. has been elected councillor for two years to represent the Kootenay Branch of the Institute.

Mr. Gwyer was born at Vancouver and had his early education in Penticton, B.C. He followed his engineering studies at the University of British Columbia and received a B.A.Sc. degree in civil engineering in 1936.

He assumed the duties of construction engineer in 1938 on coastal defense installations with E. J. Ryan Contracting Company and Northern Construction Company Limited.

Mr. Gwyer served with the Royal Canadian Air Force from 1940 until the end of World War II. He commenced his service as a pilot officer in navigation in Canada and England. He was, in 1943, named a Member of the British Empire. On his discharge he held the rank of squadron leader.

In the first five post-war years Mr. Gwyer was associated with the firm of Stevenson and Kellogg Limited and was engaged in plant layout, time, method and organization studies, job evaluation, as well as standard cost and budgetary control installations.

He joined the staff of the Consolidated Mining and Smelting Company Limited in Trail, B.C. as an assistant to the construction superintendent in 1949. Three years later he was named assistant manager of the company's engineering division.

In 1954 Mr. Gwyer was elected chairman of the Kootenay Branch of the Institute. He has been a Member since 1950.

He is a member of the Association of Professional Engineers of British Columbia.

W. K. Gwyer, M.E.I.C.

THIRTY-FIVE YEARS AGO

Comment on the Journal of June, 1922

The most important item in the contents of the *Journal* of June, 1922. was undoubtedly the report of the Institute's Committee on Policy, which occupied nearly eight pages of solid text and was accompanied by four additional pages of appendices, tables and charts. Space does not permit us to quote at any great length from it, but we may at least set down here what the committee favoured, in its own words:

Broadening of the Institute's objectives . . .; More effective co-operation with sister societies . . .; Gradual verification of the status of the Institute as the one national . . . professional organization; . . . Internal economy changes (that) will strengthen the branches . . .

Making Council more . . . representative . . .; Mileage to Councillors . . .; More . . . general distribution of the . . . office of vice-president . . .

Recognition . . . of the . . . importance of . . . engineering educational facilities . . .; Action to link . . . the Institute . . . with . . . students in engineering . . .

Action to secure . . . recognition for the engineering profession comparable to that extended to . . . law and medicine . . .

Analysis of the . . . code of ethics, so that it may be more of a positive influence . . .; Action toward securing just and adequate remuneration for engineers . . .

We leave it to readers to form their own judgments as to how far these suggestions have been implemented over the past thirty-five years. Our own feeling is that most of them have been pretty well taken care of, so far as it is in the Institute's power. Some of them depended almost entirely on the attitude of the individual member, e.g., the Institute's national standing and the influence of the code of ethics, so the Institute as an organization could do little more than encourage and support its members, which it did.

Technical Papers

Of the three papers in this *Journal*, "The Self-corrosion of Buried Lead Pipe", by W. N. Smith, M.E.I.C., and Professor J. W. Shipley, both of Winnipeg, was the most important; the second half of this paper was to appear in July, 1922, and both parts were by way of being an extension of a similar paper dealing with cast iron pipe and published in the *Journal* for October, 1921. The conclusion of the authors is that not all corrosion of buried pipe can be charged to electrolysis.

The two other papers were on 220 kv transmission, by J. F. Peters, and a description of the Bell Island iron mines in Newfoundland, by S. C. Mifflin, A.M.E.I.C. It might be noted that the first 220 kv transmission system was just going into service in California.

Branch Affairs

If one has the patience to plow through the reports of the branches, he will sometimes find there bits of information which may tickle his funny bone. Some branch treasurers were congratulating themselves on winding up their fiscal years with money in the bank, though the credit balance might be as low as 87 cents. We wonder if operating a branch within its budget is as much of a task now as it seems to have been in 1922.

Col. H. C. Boyden of the Portland Cement Association, Chicago, was touring the branches, expounding the theories of concrete design, mixing and placing of Duff Abrams. By June, 1922, he had visited Montreal, Peterborough, Halifax, Quebec and Saint John. The Canada Cement building in Montreal had just been completed and was cited as an example of what could be accomplished by rigid control. The compressive strength of the concrete in this building varied less than four per cent from the desired value.

The Hamilton Branch had inspected the Burlington Canal bridge and was present at its official opening, when it was christened "by breaking a bottle, said to contain liquor, over the main trunnion. The cheering died down suddenly 'when the ancient odour failed to materialize." This bridge was of the Strauss bascule type, of 160-foot span and with a 22-foot roadway, one street railway track and two 9-foot sidewalks.

The sixteen branches reporting in this *Journal* had all had prosperous years, with membership up in some cases by over a hundred per cent and with balanced budgets. Their reports all breathed a spirit of optimism, though all agreed that in general business was bad and jobs few and far between.

Engineering Legislation

The Engineer's Act was before the Ontario legislature again. The general atmosphere seemed to be favourable to its passage, but some M.P.P.'s did not like its Clause 34, which set the penalties for contravention of the Act. A revised version was being prepared by the legislative committee, the Institute's Ontario advisory committee and the executive of the Toronto Branch.

Readers who use the Canadian Pacific Railway Company's Windsor Station in Montreal will be quite familiar with the company's memorial to those of its employees who fell in World War I. This was unveiled by Lord Byng on April 22, 1922. Of all the numerous similar memorials we have seen, this is our favourite. Its conception seems to us better than execution is equally good. This is just our personal opinion; doubtless a professional art critic could point out to us wherein we are all wrong.

Salary demands in 1922 were modest. One advertiser in this *Journal*, a civil engineer with two years' experience in the pulp and paper industry, asked for $165 to $180 a month, while a mechanical engineer with seven years' experience as a plant engineer, wanted $275 a month, about five-eighths of a green graduate's salary today.

1922 Graduates

We see the names of a good many friends and acquaintances in the graduation lists of Queen's and McGill, published in this *Journal*, and in the considerable number of personals and lists of applicants for admission or for transfer. There are too many to mention, and they would probably mean little to the reader, but some he would recognize as those of well known business leaders of today and of members active in Institute affairs.

R.Del.F.

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

QUEBEC

Thirty-Eighth Annual Meeting

The 38th Annual Meeting of the Corporation held March 23 at the Mount-Royal Hotel, Montreal was the most successful one in the history of the Corporation. The business meeting in the afternoon was attended by 300 members; 600 members and their guests were present at the dinner and many more turned out for the dance.

Slowly But Surely

In opening the business meeting, the chairman, President L. Roy made the following observations: "Your Council, Gentlemen, made every possible effort during the year to achieve whatever you asked of it; matters arising from the last general meeting, from the referendums held during the year or from visits we made to different sections. I submit respectfully that your Council accomplished much work. Elaboration of these remarks is contained in the annual report which, undoubtedly, you have read. We leave it up to you to judge for yourselves.

Before proceeding to the discussion of the annual report, please permit me to voice a few remarks:

The sole objective of the Corporation is the common good of all and is not designed for the exclusive advantage of a group or of an individual at the expense of others. This spirit of one for all and all for one motivated your Council and the decisions it reached this year.

We believe it might be opportune to emphasize anew that the application of any law cannot be extended further than the limit set by the legislator. The law governing professional engineers is no exception. Thus the reason why your Council advocates making haste slowly because it would be unfortunate if any premature decision were to cause more harm than good to the profession.

There are some among our membership who maintain that the Council acts too slowly and that it lacks both initiative and firmness. What should never be lost from mind is that such claims come most frequently from a minority group and that their accusations are ill-founded, for the most part, or their sponsors have an axe to grind. I would venture that if these complaints where submitted to the members by means of referendums, they would receive a hostile reception in the majority of cases.

The Council cannot and should not reach decisions which could endanger the fundamental basis of the Corporation and, in so doing, could weaken its status in the eyes of its members and of the public. The Council has a duty to perform. It also shoulders a responsibility—the responsibility of protecting its members and the public, not of protecting one group of its members at the expense of others or one group of its members to the detriment of the public!

Plan For Unity

Guillaume Piette, who acted as chairman of the Committee on Confederation in 1956 submitted the report of his committee. So active was the latter that it was able, in only a year's time, to analyze thoroughly the many aspects of the Plan for Unity and arrive at a list of recommendations.

The committee's report was submitted to Council in February, and received the latter's approval. It has recently been transmitted to Dominion Council for consideration at its next annual meeting in June.

Employee Engineers

The report of the Committee on the Advancement of the Employee Engineer was received with great interest. Exemplifying this were the following comments from one of the members present: "My impression is that this committee has just been formed in the last year and, glancing over their report, as we say sometimes, it is pregnant with possibilities. In other words, this report certainly covers a very vast field. I think they are to be congratulated on the scope of their work."

Recommendation was made in the report "that the Corporation undertake a complete and thorough study on the feasibility and format of an individual obligatory contract between engineer and clients (i.e. employers)." W. J. Riley, chairman of the Montreal sub-committee explained that this came as a result of a petition which was submitted to the sub-committee by a group of Montreal Corporation members. He added that this matter had not yet been investigated, but that it will be, provided of course that Council approves of it.

It was moved, seconded and approved that study be also made on the possibility of sponsoring an employment contract between groups of engineers and their employers.

Remuneration

R. K. Eadie, chairman of the committee on remuneration explained that the task of finding means of promoting better salary conditions for engineers is a long and arduous one. He went on to say that the technique which has been in use in Ontario for some years now and which is presently being implemented in this Province "will have quite a few unsuspected developments which will greatly influence our position in the salary field."

Concluding Remarks

G. L. Wiggs, who, in his capacity of past-president sat on the outgoing Council, was invited to say a few words. Mr. Wiggs said in part: "I say that the title "engineer" is one which should be guarded very zealously by every member of the Corporation not merely by the consulting engineers." And he added: "There should be more efforts made to prevent the abuse of the title and possibly illegal practice — but the abuse of the title certainly."

R. A. Phillips, vice-president, 1956 Council and outgoing member of Council was also requested to address the meeting. Commenting upon factors which are going to be important in the future of the Corporation, Mr. Phillips said: "The first one that comes to my mind is the importance of the Corporation and its members not losing sight of the basic objectives and responsibilities that we have and our first and foremost responsibility is to serve the best interests of the public in the best way we know how. Another factor that has come to my mind is that we must not confuse our thinking by categorizing or segregating ourselves into groups but rather, if we are going to grow and progress as we want to, we must strive constantly to bring ourselves together as professional engineers of Quebec. That brings to mind another point, and it is the last point I would like to make; and that is the question of professionalism. If we are going to strive to achieve a unity of professional engineers of Quebec, we must keep in mind professionalism . . . the first requirement being to place the interests of society ahead of one's own."

Mr. Roy concluded the meeting by

saying: "Sol lucit omnibus. Assuredly, God will be in His Heaven and all will be right with the world if we keep faith in our profession and maintain its spirit by observing our Code of Ethics at all times."

New Council

Immediately after the business meeting, the new Council met and elected its officers for the current year. They are: C. A. Peachey, president; Guillaume Piette, vice-president; L. Nadeau, honorary secretary-treasurer. Other members of Council are: L. Roy, past-president; Robert Painchaud, Yvon De Guise, W. J. Riley, and A. G. Ballachey.

Dr. O. M. Solandt

Guest speaker at the annual dinner was Dr. O. M. Solandt, vice-president of research and development with Canadian National Railways who delivered a major speach on "Some new Responsibilities for Professional Engineers".

Dr. Solandt emphasized the need for more and especially for better-trained engineers, engineers who will maintain the highest ethical and technical standards and assume social leadership as it is becoming increasingly incumbent upon them to provide such leadership in this era of great technological development.

The Dumont Family

The Dumont family of engineers, a father, seven sons and a daughter married to an engineer, were honoured at the annual dinner. Joseph Dumont, 78, who lives in Amos, was given a certificate of honour in recognition of his contribution to the profession and to the development of the north-western region of the province.

Mr. Dumont's sons are: Georges, Wilfrid, Lomer, Rodolphe, Eudore, Paul and Robert. Georgette, Joseph Dumont's eldest daughter, is married to Benoit Marcotte. Another daughter, Marthe, is a student.

Exhibition of Film Slides

Twenty-Five Corporation members participated in the Exhibition of Film Slides held at the time of the annual meeting. More than 400 slides were carefully screened by a group of Montreal art critics before the winners of the exhibition were picked. They are: — Maurice Desjardins, first prize; Gilles Gagnon, second prize; Claude Lacombe, third prize.

ONTARIO

Engineers in the News

Thomas J. Nolan, of Atlas Steels Ltd., Welland, Ont., has been given the post of chief engineer of the company.

A graduate in electrical engineering of the University of Toronto, Mr. Nolan joined Atlas Steels in 1943 after several years with Ontario Hydro and the Chemical Construction Corporation. With the exception of 1956, when with H. G. Acres and Co. Ltd., he has been a member of the Atlas engineering department since 1943, being appointed electrical engineer in 1948 and assistant chief engineer in 1956.

C. T. Muirhead of Canadian Vickers Ltd., has been appointed technical manager of engineering sales with headquarters in Montreal.

Mr. Muirhead has been with Canadian Vickers for a number of years and for the last four years has been manager of the Toronto office.

A. W. F. McQueen, president of H. G. Acres and Co. Ltd., of Niagara Falls, Ont., has announced several staff appointments in that firm. **R. A. H. Hayes** has been named chief engineer of the technical division; **J. H. Ings**, chief engineer of special projects; **J. Hvilivitzky**, chief engineer special projects; **W. P. London**, chief engineer, thermal division; **C. N. Simpson**, chief engineer, hydraulic division; and **H. P. Schweder**, chief engineer, petrochemical division.

Gerald L. Sandler, of Chrysler Corporation of Canada Ltd., Windsor, Ont., has been named to fill the newly created post of organization analyst of the company. His duties will include the responsibility of conducting special studies into the organization of corporation activities.

Mr. Sandler graduated in engineering from Toronto and subsequently obtained his master's degree in business administration from the University of Michigan. He is also a graduate of the Chrysler Sales Analysis Institute and joined Chrysler in 1955.

MANITOBA

Hoogstraten to N.S.T.C.

Professor Jack Hoogstraten, of the University of Manitoba, retiring president of the Association, has accepted an appointment as president of the Nova Scota Technical College. Mr. Hoogstraten served as president of the Association from 1955 to 1957 during which time membership grew from 544 to 835. Well-equipped offices and a permanent secretary were also secured. In the fall of 1956 the Association began publication of its own newspaper. A great deal of the credit for its initiation goes to Mr. Hoogstraten.

As to the future of the Association Mr. Hoogstraten feels that the greatest problem to be faced by the Association is the shortage of technically trained personnel and that it is a responsibility of the Association to participate in steps to alleviate this situation. A recent development is the proposal to train "engineering technicians". These men, rather than taking the full four years engineering course, would receive intensive training in a narrow range or phase of a particular engineering field for a much shorter period. Mr. Hoogstraten supports this proposal and feels that the engineering associations will have to take the lead in establishing curriculums and controls since only professional engineers will know the training required.

BRITISH COLUMBIA

Engineers in the News

Professor F. W. Vernon of the mechanical engineering department, U. B. C., was recently honoured by former students at a banquet held to mark his retirement. Professor Vernon was presented with a hi-fidelity set at a dinner held in the Hotel Georgia, Vancouver. The professor came to U.B.C. in 1926.

R. C. Robson has accepted a position with Crown Zellerbach Canada Limited as plant engineer, Canadian Western Lumber Company, Fraser Mills. Mr. Robson was formerly with H. A. Simons Limited.

J. Pomeroy, has been promoted to regional maintenance engineer for No. 2 Region, B.C. Department of Highways. His operations will center around Kamloops, B.C.

E. Cecil Roper, has been elected Director of Howe Sound Company. He became executive vice-president of the company in 1956.

A. N. Lucie-Smith, has been appointed to an engineering position with the petroleum natural gas branch of the Department of Mines, Province of British Columbia.

T. F. Hadwin, has been appointed district manager of the Bridge River Area, with the B.C. Electric Company Limited, at Shalath, B.C. He was formerly superintendent of substations with the company.

ALBERTA

Thirty-Seventh Annual Meeting

The thirty-seventh Annual Meeting of the Association of Professional Engineers of Alberta, held at the Palliser Hotel, Calgary, on March 30, 1957, was called to order by president J. G. Dale. Present were four hundred professional engineers and E.I.T.'s.

Visitors representing the E.S.S. and Mining and Geological Society of the University of Alberta, the B.C. Association, the Ontario Association and the Saskatchewan Association were introduced and welcomed to the meeting.

J. J. Hanna, representative on the Dominion Council, P. M. Sauder, from the E.I.C., and J. G. Dale, engineering faculty Council Representative read their reports. J. F. McDougall gave the report as registrar, and made some interesting comparisons of membership records during the ten years in which he has acted as registrar of the Association. He stated that ten years ago the total registered membership was 410 as compared with 2055 today. Twenty-four members attended the Annual Meeting ten years ago. Mr. McDougall also reported on the Student Loan Fund, and on Scholarships and Medals.

Public Relations

In a report from the Public Relations Committee, J. N. Ford, chairman, discussed setting up of branches of the Association throughout the province; liaison with the university students; and the revision, by a sub-committee of the Information Booklet with the object of selling the Association. The sub-committee pointed out the need for an Association objective; such an objective to provide a basis for selling the Association. As a result, several of the recommendations of the Council have been approved. The purpose of the Association of Professional Engineers of Alberta is to serve and safeguard the public by ensuring that only those who have the proper qualifications shall practice engineering; insisting that the members achieve self-discipline through following the Code of Ethics; being concerned with the standards of education; educating employees and the public as to the goals, ideals, practises, and ethics of the professional engineer. The Association will also present membership certificates during a suitable ceremony; will be the ways and means of producing closer liaison with the technical engineering societies; supply the Professional Recognition Bulletin; and employ Public Relations counsel. It was recommended that consideration be given to the employment of such counsel.

Counselling and Education

Submitting the report of the Counselling and Education Committee, J. G. Dale, in response to a question as to what success career nights and the Provincial Guidance Branch have had, replied that their effect is threefold. Students who should further their education are encouraged; direction in the correct fields of endeavour is given; and those who may not be prepared or qualified for engineering are discouraged. Professor L. E. Gads explained the organization of guidance programs.

It was also reported that work is proceeding on a draft of a counselling pamphlet designed for use in Alberta by the University, the provincial director of Guidance, and the Association office. A comparison was made of the entrance requirements for, and the courses taught in the first year of engineering at the Universities in Canada. The committee also recommended that the Association participate in a television Guidance or Counselling program being sponsored by the Edmonton South Side Kiwanis Club. Speakers on professional engineering have been provided for the Provincial Guidance Branch and the Edmonton School Boards. The Calgary section of the Committee has started work on a study of the place of technical schools in Alberta.

Forum Discussion A forum discussion was also held on the question "Should the Engineering Profession Act provide for separate designations for Geologists and Geophysicists?" It was decided by a four-man panel that more study should be given this matter by the Act and By-Laws Committee.

Legal Aspects G. M. Blackstock, QC., former chairman of the board of Public Utility Commissioners, discussed "The Legal Responsibilities of A Professional Engineer".

Election of Officers

Elected president by acclamation was Dr. J. C. Sproule; vice-president, Dr. G. W. Govier; and four councillors for a term of three years; Dr. R. N. McManus, W. D. Stothert, C. W. Coote, R. D. Halk. Serving as councillor for a term of two years is B. A. Monkman.

The new president and councillors were then introduced to the meeting.

Right Honourable C. D. Howe

The Right Honourable C. D. Howe was introduced to the dinner audience as an outstanding engineer, who in 1935 left a flourishing consulting practice to enter the rough and tumble of the political arena. In his speech, Mr. Howe suggested by argument and personal example that despite the alleged shortage of engineers in the profession, the political field offered fertile soil for the engineer. Among the restrictive qualifications that Mr. Howe thought to mention, however, were middle age and private means. Mr. Howe entertained his audience by a sprightly account of the part that he and the government had played in developing Canada's resources by encouraging with government aid the inauguration of industries and public services that private enterprise could not alone have initiated.

The success of Mr. Howe's address may be measured by the fact that even the most hard-headed of his opponents left the meeting feeling that, after all, the government's part in financing the Trans Canada Pipe Line might have its merits.

A.R.C. Director is Speaker

Dr. N. H. Grace, director of the Alberta Research Council, in his address to the luncheon audience outlined the part played by his organization in developing Alberta's natural resources.

Since its inception in 1919 the Research Council has been primarily interested in the province's fuel reserves and their effective utilization. Dr. Grace outlined the researches presently conducted on coal, natural gas, petroleum and oil products. Naturally, the geology of the province is of vital importance to the proper development of fuel resources, and therefore the Research Council maintains an active geology group.

The Council, it was explained, has for many years offered the services of its group of industrial engineers, who collaborate with the National Research Council technical information service to assist provincial industries.

Provincial soil surveys and irrigation programs have been assisted by the work of the Research Council; and a recent development has been the formation, under the direction of Dean R. M. Hardy, of a highway research group. Another recent project, which was started last year, is an investigation of cloud systems (made in conjunction with several provincial and federal groups) in the hope of overcoming the problems of hail damage.

President's Address

Delivering the president's address Mr. Dale said that his talk was chosen with a view to its usefulness to the young engineer. Whether he remains within his own field or finds himself in one other than the one in which he specialized, Mr. Dale said that as he continues in his field or even advances in it he will likely find that he is dealing in two things that may greatly affect his situation and which were not included in his early training. These are business, and people. Such things as accounting, marketing and business organization and the inexact sciences of human relations, personnel problems and labour relations may well baffle the engineer as he seeks advancement.

Advancement and Administration The further an engineer advances in his company the closer he comes to or the more he becomes involved in administration and its attendant problems. In his rise to an administrative post, one of the things to be learned is the necessity of delegation. He will probably receive a great deal more delegated work and authority than he will give. On his ability to execute this may depend his promotion into administration. Mr. Dale said that there is a strong comparison between an engineering report on a problem with its resulting conclusion and completed staff work, and described the terms "staff" and "line" as they apply to engineers.

Stressing the importance of "completed staff work" he remarked that its benefits are twofold. The chief is protected from half-baked ideas, voluminous memorada and immature oral presentments. The staff man who has a real idea to sell is enabled more readily to find a market.

Concluding his remarks Mr. Dale stated that he had presented two thoughts, one of which was that an engineer may not practice in his field of study and that he will learn his specialty after graduation, and that secondly, a chance of promotion may be better in business administration and may be enhanced through further study of the methods of doing business and of handling people.

OBITUARIES

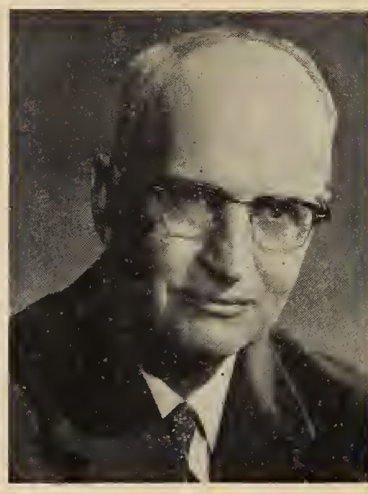
The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

John Dibblee, M.E.I.C., assistant general manager of personnel with the Hydro-Electric Power Commission of Ontario, who recently observed his fortieth anniversary of service, died on April 4, 1957, while on vacation at Montego Bay, Jamaica, B.W.I.

Born at Woodstock, N.B., on May 7, 1894, Mr. Dibblee had his general education there and then proceeded to the University of Toronto where in 1915 he was awarded a bachelors' degree in applied science.

In his first year as a graduate he gained valuable experience as a job foreman at Georgetown for the Lambton-Guelph Railway and as a demonstrator in hydraulics, in the faculty of applied science and engineering, at the University of Toronto. Early the following year he joined the firm of Smith, Kerry and Chase as a resident engineer for a twelve month period. Beginning his association with the Hydro-Electric Commission in 1917, he was with the station design section. He also served with the R.A.F. during World War I and on his return to the Commission became a district operating engineer, on the Eastern Ontario System. In 1926 he was named general superintendent of the Niagara Falls district of the company. Five years later in 1931 he became assistant chief operating engineer and in 1937 he was named assistant chief engineer. Promoted to the post of chief engineer in 1945, he was called in to take over the responsibility of manager of personnel in 1947. In 1955 he became assistant general manager of personnel.

As manager of personnel, Mr. Dibblee pioneered a significant advance in Canadian labour-management relations. At the commencement of the construction of the $340 million Sir Adam Beck Niagara Generating Station No. 2, Mr. Dibblee foresaw that the Commission would be involved, for the first time, in bargaining with the international unions. He played a part in the establishment, by eighteen A.F. of L. craft unions, of an Allied Council and negotiated with this council on behalf of the Hydro, a single agreement covering the entire project. This was the beginning of a new experience in labour-management relations for the contractors and their supervisors, and for the men and their union representatives.



J. Dibblee, M.E.I.C.

During the entire five-year project, on which 5,000 men worked at the peak, not a single hour was lost through work stoppage.

The relationship between the Commission and the Council of eighteen A.F. of L. Unions has been described as being without parallel in Canadian history, the essence of it being a whole-hearted trust and confidence founded on forthright honesty and understanding, that has to be lived to be understood. The main credit for this was given to Mr. Dibblee, whose constant concern was for men in Canadian industry to understand the ideological nature of events in the world today, and to begin to live in industry an adequate answer.

Mr. Dibblee attributed any effectiveness he may have had in labour relations to his training in Moral Re-Armament, and said, "We have an entirely new relationship of inestimable value, in which both sides try their utmost to cure their own shortcomings."

The Allied Council principle was later extended on a province-wide basis to construction forces on other projects including Hydro's St. Lawrence Power Project.

Mr. Dibblee's role in labour relations began in 1936, when the Employees' Association was formed. He took an active part as management's representative in the initial organization of this group, and before negotiations the following year, acted as a member of the Working committee. In later years he became associated with the Labour Relations Committee and in 1947 assumed responsibility for representing the Commission in negotiations with the bargaining unit, the Employees' Association.

Mr. Dibblee was a member of the Association of Professional Engineers of Ontario and was also active in the American Institute of Electrical Engineers.

Mr. Dibblee joined the Engineering Institute as a Member in 1939.

Joachim Antonisen, M.E.I.C., retired engineer of Port Arthur, at one time city engineer at Port Arthur, Ont., died in that city on April 16, 1957.

J. Antonisen, M.E.I.C.

Mr. Antonisen was born at Christiania, Norway on February 24, 1869. He attended schools at Bergen and at Christiania and spent three years in the United Stats in railway work before embarking on a four-year engineering course at the University of Dresden, Saxony, from which he graduated in 1898. He was an assistant engineer with the Saxon Government Railways for the first two years of his graduate career. He then transferred to another department and received an appointment as assistant engineer on roadbuilding and river improvement. Four years later, in 1904, he emigrated to Canada. Beginning his career in the new world with the Canadian Pacific Railway at Winnipeg he was the following year named city engineer at Port Arthur and later, in 1911, was made manager of all public utilities. He also took on an appointment as City engineer for the municipality of Moose Jaw, Sask, for a short time and carried out several private engineering enterprises in connection with railroad yard construction and elevator construction work. He held the appointment of City engineer at Port Arthur until the time of his retirement from public life in 1935.

Mr. Antonisen has always maintained an interest in the affairs of the Lakehead Branch of the Institute and was in 1935 chairman of that Branch. Since then it had been his custom to tender a vote of thanks each year to the visiting president of the Institute. Mr. Antonisen will be well remembered by all those who had occasion to be so addressed by him during the past seventeen or eighteen years.

Mr. Antonisen joined the Institute as an Associate Member in 1907 and transferred to Member in 1921. He attained

Life membership in the Institute in 1937.

James Patton Gordon, M.E.I.C., retired official of the City Engineers' Department, at Hamilton, Ont., died on January 31, 1956 in that city.

Born at Toronto on January 3, 1883, he was a graduate of the class of 1904 at the School of Practical Science of the University of Toronto.

Engaged in engineering projects while yet a student Mr. Gordon had had experience in the fields of land surveying and draughtsmanship, the latter with the Canadian Pacific Railway before graduation. Later he worked with an Ontario Land Surveyor on township subdivision, was locating engineer on the transmission line of the Toronto and Niagara Power Company in 1905, and a draughtsman on a railway survey the following year. For the Toronto firm of Chipman and Power, consulting engineers, at Toronto he was engaged as an assistant in charge of construction of Waterworks and Sewers in 1907 and remained in this work for a number of years at various points across the prairie provinces.

He was with the City engineer's department of the City of Hamilton for thirty years.

Mr. Gordon joined the Institute as a Student member in 1907; became an Associate member in 1913 and a Member in 1940. He attained Life Membership in 1949.

Harold Forsyth Finnemore, M.E.I.C., retired chief electrical engineer with the Canadian National Railways, Montreal, died on April 8, 1956, in Montreal.

Mr. Finnemore was born at Chicago on March 18, 1893 and gained his engineering qualifications at Queen's University where he was awarded a B.Sc. degree. He enlisted with the Royal Canadian Engineers in 1914 and served overseas in World War I. On demobilization he joined the Canadian Government Railways at Moncton, N.B., as a draughtsman in the electrical engineering department. Five years later he became assistant electrical engineer in the Canadian National Railways mechanical department at Montreal, and in 1938, electrical engineer. He was appointed assistant chief electrical engineer in 1943 and chief electrical engineer in 1945. He retired in 1956.

Mr. Finnemore was latterly engaged in the development of electric motive power and installations, and the introduction of air-conditioning on the Canadian National passenger equipment.

Mr.Finnemore served the Institute for several years as a member of the Library and House Committee and was a member of the Council from 1948 to 1950.

Mr. Finnemore was also chairman of the planning and building committee of the Protestant School Board of Greater Montreal.

He joined the Institute as an Associate Member in 1921 and was transferred to Member in 1940. He gained Life Membership in 1956.

Beverley A. Evans, M.E.I.C., supervising engineer in charge of design services with Du Pont Company of Canada (1956) Limited, engineering department, at Montreal, died in that city on May 16, 1957.

A native of Kingsey, Que., where he was born on January 14, 1903, Mr. Evans was a graduate of the University of Saskatchewan, graduating with a B.Sc. in civil engineering in 1930 and an M.Sc. in 1936.

He had been design engineer for Saskatoon on that city's Broadway bridge, assistant secretary-treasurer of the town of Asquith, Sask., chief designer and resident engineer for the federal public works department on the Bordern Bridge in Saskatchewan and was responsible for the design and construction of the Kingston, Ont., nylon plant of Du Pont of Canada.

During the war he was assistant project engineer for Defence Industries Limited on the design of the de Salaberry, Que., smokeless powder plant and undertook secret war work for the National Research Council.

H. F. Finnemore, M.E.I.C.

Mr. Evans joined the Institute as an Associate Member in 1937 and was transferred to Member in 1940.

Lewis J. Barron, M.E.I.C., district manager of the Foundation Maritime Limited, construction department at Halifax, N.S., died suddenly on March 15, 1957 in that city.

Born at St. John's, Newfoundland on January 7, 1914 he had his early education there and later studied engineering at the Nova Scotia Technical College. A 1941 graduate in civil engineering, his first graduate appointment was with the Pictou Foundry and Machine Company Ltd., shipbuilding division, as plant engineer. This followed experience gained while a student and prior to that time, with various concerns, including the Newfoundland Government, the Anglo-Newfoundland Development Company Limited, the Department of Natural Resources, Newfoundland and the Department of Mines, Province of Nova Scotia.

In 1943 he accepted the position of maintenance and safety engineer, Foundation Maritime Limited, shipbuilding division at Pictou, later transferring to the engineering construction department in Montreal. With the Foundation Companies a total of fifteen years he was associated with many spectacular projects across Canada, in particular at Churchill, Man., where he spent more than two years. Among other projects supervised by Mr. Barron from the Montreal office were the construction of water intakes for paper mills at Hawkesbury, Ont., and Cap de la Madeleine, Que. For three years he held the post of supervisor at Montreal of the Canadian Johns-Manville Company Limited Construction program at Asbestos, Que.

Mr. Barron joined the Institute as a Member in 1943.

John Frederick Mellish, M.E.I.C., retired district engineer of the Harbours and Rivers Engineering Branch of the Department of Public Works, at Winnipeg, Man., died at his new home in Penticton, B.C., on February 22, 1956.

Mr. Mellish was born at Galt, Ont., on June 24, 1892. He attended the Galt Public School and Collegiate Institute, the University of British Columbia and the University of Washington, Seattle, where he was graduated with a B.Sc. in civil engineering in 1918. He worked with the former Department of the Interior as a resident engineer in the national parks of British Columbia at that time and the following year transferred to Alberta to accept a similar position, which he held until 1925. Briefly associated with the Sydney Junkins Construction Company as a field engineer at Vancouver, for a twelve-month term, he later transferred to the Department of Public Works of Canada at Ottawa, as a junior engineer, early in 1928. Promoted to assistant engineer and senior assistant engineer transferred to Winnipeg in 1936 and 1944, he was to become acting district engineer for the Department at Winnipeg in 1947. On his retirement Mr. Mellish was district engineer of the Harbours and Rivers Engineering branch.

Mr. Mellish was a member of the Association of Professional Engineers of Manitoba and of the American Wood Preservers Association.

He became a Member of the Institute in 1948.

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Secretary, G. H. Rogers, c/o Engineering Institute of Canada, 236 Avenue Road, Toronto.

Personals

News of the Personal Activities of Members of the Institute.

Dr. O. M. Solandt, HON. M.E.I.C., assistant vice-president, research and development, with the Canadian National Railway has been appointed vice-president of the division.

Dr. Solandt, who is a native of Winnipeg, followed a career in physiology, worked on the teaching staff of the department of physiology at Cambridge, and became a Fellow of Trinity Hall. During World War II engaged in research on the relation of physiology to warfare, in Great Britain, he was in 1944 named superintendent of the Army Operational Research Group.

In the immediate post-war years he served with a military mission at Hiroshima and Nagasaki on the evaluation of the effects of the first atomic bombs.

Later in 1946 Dr. Solandt returned to Canada to join the Department of National Defence in Ottawa to take on the job of forming a permanent defence research organization for Canada. Dr. Solandt was the first chairman of the Defence Research Board in 1947 and a scientific member of the chiefs of staff committee and defence council.

Air Commodore C. A. Cook, O.B.E., M.E.I.C., has been appointed an air vice marshal and air officer commanding the Air Material Command of the R.C.A.F.

Air Vice Marshal Cook held the appointment of chief logistics officer at headquarters since 1952.

A graduate of the University of Saskatchewan, class of 1933, he was commissioned in the Royal Canadian Air Force in 1939. Overseas during the Battle of Britain in 1940 he served as an engineering officer with No. 112 Army Cooperation Squadron. On his return to this country he became staff officer at various stations and headquarters, and later took over a position in the Directorate of Postings and Careers, at Air Force Headquarters in Ottawa. In 1948 he was posted to the Canadian Joint Staff, Washington, D.C., returning to the Air Material Command headquarters as senior logistics planning officer.

For distinguished wartime service Air Vice Marshal Cook was appointed an officer of the Most Excellent Order of the British Empire in 1946.

A/V/M C. A. Cook, O.B.E., M.E.I.C.

G. Penney, M.E.I.C., who has had extensive experience in the pulp and paper industry with the Bowater and international paper organizations has been appointed vice-president of Sandwell International Limited.

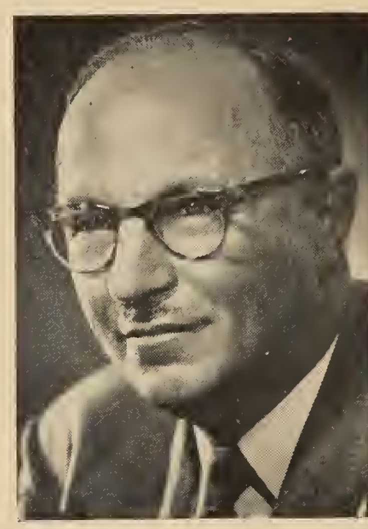
Mr. Penney who is a Queen's University graduate, class of 1925, was mill superintendent at Bowaters Pulp and Paper Mills, Newfoundland from 1938 to 1945. At that time he received the appointment of mill manager.

Sandwell International, formed in 1955, to provide management services has been awarded a management contract by the Pakistan Industrial Development Corporation, in connection with a pulp and paper mill in East Pakistan.

S. W. Fraser-Underhill, M.E.I.C., has been elected to the board of directors of the firm of Ewbank and Partners (Canada) Limited, engineering consultants, and has been named general manager of the firm. Since its establishment in 1954 Mr. Fraser-Underhill has taken a prominent part in bringing the company to its present state of activity.

E. E. Orlando, M.E.I.C., of the Canadian Westinghouse Company Limited has been appointed a vice-president of the firm.

Mr. Orlando, who has spent thirty years with Westinghouse is in charge of the district apparatus division of the firm which includes heavy apparatus sales, application engineering, and service facilities across Canada. This was one of three new operating divisions formed by the company at the time of his appointment to the post early in 1953. Prior to that time he was eastern regional manager of the Company.



O. W. Titus, M.E.I.C.

Dr. Otto Holden, M.E.I.C., chief engineer of the Hydro-Electric Power Commission of Ontario addressed the Commonwealth Section of the Royal Society of Arts, London, England on May 9, 1957.

Internationally known in engineering circles, Dr. Holden devoted much of his address to a discussion of the St. Lawrence Seaway and Power Project, with special emphasis on the power development being built jointly by the Ontario Hydro and the Power Authority of the State of New York.

Before returning to Canada later in the month Dr. Holden conferred with eminent British engineers and inspected some of the principal power developments in the British Isles.

O. W. Titus, M.E.I.C., who has since 1952 held the appointment of vice-president and general manager of the Canada Wire and Cable Company has been elected to the post of president of the organization.

Mr. Titus who started his engineering career with a B.A. Sc. degree gained at the University of Toronto in 1917 joined his present firm in 1929, being at the same time associated with the Underground Cable Company of Canada. As chief electrical engineer and chief engineer he was representative for Canada Wire and Cable Company on such standardization bodies as the Canadian Engineering Standards Association. Instrumental in some of the most difficult cable installations in Canada, Mr. Titus was responsible for the design and installation of a 120,000 volt underground cable system including cable and accessories supplied to the Montreal Light, Heat and Power Commission in 1940.

In 1948 vice-president of the English Electric Company of Canada Limited, he became at that time also general manager of the Canada Wire and Cable Company Limited.

Mr. Titus has served as a member of the Canadian National Committee International Conference on Large Power Systems and the National Executive of the Canadian Manufacturers' Association.

G. R. Davis, M.E.I.C., general manager of the Kingston Public Utilities Commission has been elected president of the Association of Municipal Electrical Utilities.

Mr. Davis who has beeen engaged in engineering in Kingston for several years formerly served with the Ottawa Hydro-Electric Commission in a variety of posts including that of general manager and chief engineer.

A. E. Berry, M.E.I.C., director of sanitary engineering for the Ontario Department of Health, Toronto, has been elected an honourary member of the American Water Works Association.

Mr. Berry has been with the Department of Health since 1926 and has been a member of the American Water Works Association since 1920. He represented the Canadian section on the Association's Board of Directors from 1937 to 1940 and was the Association's president in 1952. He received the George Warren Fuller Award in 1938 and the John M. Goodell Prize in 1950.

A. E. Berry, M.E.I.C.

Mr. Berry served on the council of the Institute in 1941-42, representing Toronto Branch.

S. Logan Kerr, M.E.I.C., of S. Logan Kerr and Company, consulting engineer of Fluortown, Pa., has been elected an honourary member of the American Water Works Association.

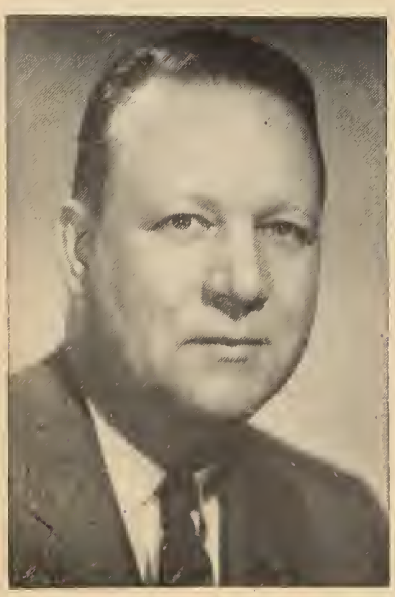
S. L. Kerr, M.E.I.C.

A member of the Association since 1935, Mr. Kerr is internationally known in the public water supply field and allied professions as an expert on water hammer effect. He has served on several of the Association's committees on this subject and is now chairman of the Association's special task committee to study allowances for water hammer.

R. G. Barbour, M.E.I.C., who has been appointed president of T. Pringle & Son Limited, Montreal. The firm has been engaged in consulting engineeering in the industrial field since 1892 and has served many prominent Canadian industries on plant design for aircraft, textiles, pharmaceuticals, asbestos and many other heavy industries.

R. G. Barbour, M.E.I.C.

Mr. Barbour was born and educated in St. John, N.B., and is a graduate of the University of New Brunswick, 1924. He was also awarded an M.Sc. degree in 1927. Following a two-year engineering course with Canadian General Electric, he spent four years with Aluminum Co. of Canada at Arvida on plant construction. From 1930 he was on design work with McDougall & Friedman, consulting engineers, until 1937 when he joined T. Pringle & Son Limited as mechanical engineer. He was appointed general manager in 1952 and vice-president and managing director in 1954.



F. H. Fargey, M.E.I.C.

F. H. Fargey, M.E.I.C., of Brown Boveri (Canada) Limited, formerly Ontario Branch manager for the organization has been named to the post of vice-president and sales manager.

Mr. Fargey is a graduate of the University of Manitoba in electrical engineering. He joined Brown Boveri in 1950 and for the past four years has made his headquarters in Toronto.

S. D. Ford, M.E.I.C., was among those three recently named to vice-presidency in the firm of Sandwell and Company Limited, consulting engineers of Vancouver.

Mr. Ford joined the Sandwell organization in 1949. He was appointed chief engineer of the firm in 1955.

A 1939 graduate of the University of British Columbia he gained experience with the Boeing Aircraft Company of Canada in Vancouver where he was in charge of the design section. In 1945 he transferred his services to the Powell River Company as assistant to the project engineer.

Edgar Lion, M.E.I.C., has been appointed chief engineer of Sir Robert McAlpine and Sons (Canada) Limited. He was formerly chief project engineer with

• PERSONALS

Montrose Builders, Inc., and prior to that engineer and chief estimator with Louis Donolo, Inc.

Mr. Lion is a graduate in civil engineering of McGill University, class of 1945.

C. S. Leclair, M.E.I.C., has been appointed chief engineer of Peacock Brothers Limited, in their new project and development department.

Mr. Leclair has held senior engineering positions in England and Japan, and prior to joining Peacock Brothers Limited directed his own consulting business in Toronto, under the firm name of Leclair Engineering Company.

During the course of his career, his original contributions to the engineering field have brought him over one-hundred and fifty patents.

W. L. Wardrop, M.E.I.C., who established engineering consulting offices in Winnipeg in 1955 under the name of W. L. Wardrop and Associates, is president of the newly incorporated company, known as W. L. Wardrop and Associates (Management) Limited. He is also a director of the firm which specializes in municipal, structural and industrial engineering.

Mr. Wardrop graduated from the University of Manitoba in electrical engineering in 1939 and received a degree in civil engineering in 1947. He joined the engineering department of the City of Winnipeg in 1937 and received the appointment of engineer of waterworks and sewage in 1949 after several years military service with the Royal Canadian Corps of Signals.

Col. W. A. Capelle, M.E.I.C.

J. E. Butler, M.E.I.C.

R. W. McKnight, M.E.I.C., has been elected vice-president of the newly incorporated firm of W. L. Wardrop and Associates (management) Limited, engineering consultants. He is also a director of the company.

He is a 1950 graduate of the University of Manitoba in civil engineering, and has had several years' experience with the Foundation Company of Canada Limited, on heavy construction at Fort Churchill, Man., on the atomic energy project, at Chalk River, Ont., and other work. More recently he has been employed with Defence Construction Limited at Winnipeg as an assistant engineer on administrative work for army and navy projects. In 1953 he joined Moody and Moore, architects, as a designer on defence construction projects.

A. V. Armstrong, M.E.I.C., former senior Canadian executive for Amalgamated Electric Corporation has been appointed manager of the magnet wire division of the Canada Wire and Cable Company Limited new modern plant now under construction at Simcoe, Ont. This plant will be the major unit.

Mr. Armstrong who started his engineering career with the English Electric Company of Canada Limited, and who is a 1923 graduate of McGill University also served the Canadian Cutler-Hammer Limited and Northern Electric Company at Toronto before joining Amalgamated Electric Corporation Limited in 1938. He was appointed president and director of the firm in 1952.

Colonel W. A. Capelle, M.E.I.C., director of works at Army headquarters, Q.M.G. Branch, Ottawa, has been elected chairman of the Ottawa Branch of the Institute.

Colonel Capelle is a graduate of the University of Manitoba, class of 1932. He joined the R.C.E. at that time and has since folowed the career which has combined engineering and a military life. At the outbreak of World War II, then commanding the 7th Army Troops Company in Winnipeg, he assumed command of the First Corps Field Park Company in Winnipeg and took the Company overseas.

E. Lion, M.E.I.C.

C. S. Leclair, M.E.I.C.

Command and regimental appointments followed and in 1944 he became staff officer of the Royal Engineers at First Canadian Army Headquarters.

For his service in World War II Colonel Capelle was awarded the Croix de Guerre avec Palme in 1946.

Since the war he has held the appointments of assistant director and then director, Directorate of Works and Accomodation, in the branch of the Quartermaster General at Army Headquarters. In 1950 he was appointed command engineer of the Central Command.

His promotion to the rank of colonel and his appointment as director of works was announced in 1952.

J. E. Butler, M.E.I.C., has been appointed manager of Sales and Fiberglas Canada Limited, at their new branch office at London, Ont., serving Southwestern Ontario.

Mr. Butler, who graduated from the University of Manitoba with a B.Sc. in civil engineering in 1950 was employed by the A. P. Greene Firebrick Company

of Weston, Ont., at the outset of his career. He has been with Fiberglas Canada Limited since 1951 in the capacity of sales engineer.

D. L. Mackinnon, M.E.I.C., has been appointed project manager of the Northern Manitoba mining and development at Thompson Lake, for the Foundation Company of Canada Limited, general contractors for the INCO development in that area.

Mr. Mackinnon who has been associated with the Foundation Company for a number of years. He was awarded an M. Sc. degree in civil engineering from the University of New Brunswick in 1944 following an initial degree obtained at U.B.C. in 1939. He gained early experience with the Foundation Company in 1940, served with the R.C.A.F. as a pilot and returned to the company in 1946 as manager of the building department of the Foundation Company of Ontario Limited, with headquarters in Toronto.

In 1948 he accepted an appointment as managing director of the Bayside Construction Company Limited, at Campbellton, N.B. and held that post for some time. Mr. Mackinnon was again with Foundation Company of Canada Limited at Montreal in 1954.

N. S. Bubbis, M.E.I.C.

J. Stuart Johnston, M.E.I.C., formerly manager of the western district of Linde Air Products Company, division of Union Carbide Canada Limited at Vancouver has received the appointment of sales manager, industrial gas products, with the organization. He will make his headquarters at the Linde General Offices in Toronto.

Mr. Johnston has been associated with the Linde Air Products Company since his graduation from McGill University in 1939. He has held positions as service engineer at Montreal and Toronto, process service manager at Montreal, and district manager at Winnipeg prior to his most recent appointments.

W. L. Garvin, M.E.I.C., is now associated with the Winnipeg office of the consulting engineering firm of Haddin, Davis and Brown Limited, of Calgary, Edmonton, Regina and Winnipeg.

Mr. Garvin obtained a B.Sc. degree in mechanical engineering from the University of Manitoba in 1950. Following graduation he was employed by General Motors Diesel Limited, and the Hydro-Electric Power Commission of Ontario at Toronto as a mechanical design engineer. For the past four years he has been with Defence Construction Limited and latterly served as area engineer responsible for the supervision of construction of new mechanical installations.

N. S. Bubbis, M.E.I.C., general manager of the Greater Winnipeg Water and Sanitary Districts has been elected chairman of the Winnipeg Branch of the Institute.

Mr. Bubbis was born in the United States, received his general education in

Winnipeg as well as his engineering qualifications. He is a 1934 graduate from the University of Manitoba in civil engineering.

At first working with the City of Winnipeg as a pipe plant inspector, he transferred to the draughting and designing branch, where he was later promoted to engineer in charge.

In 1944 he was appointed engineer of water works and sewerage. That position he held until in 1949 he was named to his present work.

He is a member of the executive of the Canadian section of the American Water Works Association; is past-president of the Canadian Institute on Sewage and Sanitation, of the Western Canada Water and Sewage Conference and of the Minnesota Section of the American Water Works Association.

A. A. Laughlin, M.E.I.C., has joined the Winnipeg office of the firm of Haddin, Davis and Brown Limited, consulting engineers. He will have charge of structural engineering design.

Mr. Laughlin is a University of Manitoba graduate, class of 1936. During

P. N. Brown, M.E.I.C.

World War II serving as a technical representative of the British Air Ministry in the Eastern United States. For the past ten years he has been with the Bridge design office of the Highways Branch, Department of Public Works of the Province of Manitoba. Last year he resigned as chief bridge and structural engineer.

P. N. Brown, M.E.I.C., has been elected chairman of the Border Cities Branch for the year 1957.

Born at Brantford, Ont., Mr. Brown received his early education in Windsor and Walkerville, Ont., schools.

During World War II Mr. Brown served with the R.C.A.F. in the South East Asia Command and on his discharge held the rank of flying officer. In 1950 he graduated from the University of Toronto with a B.A.Sc. degree.

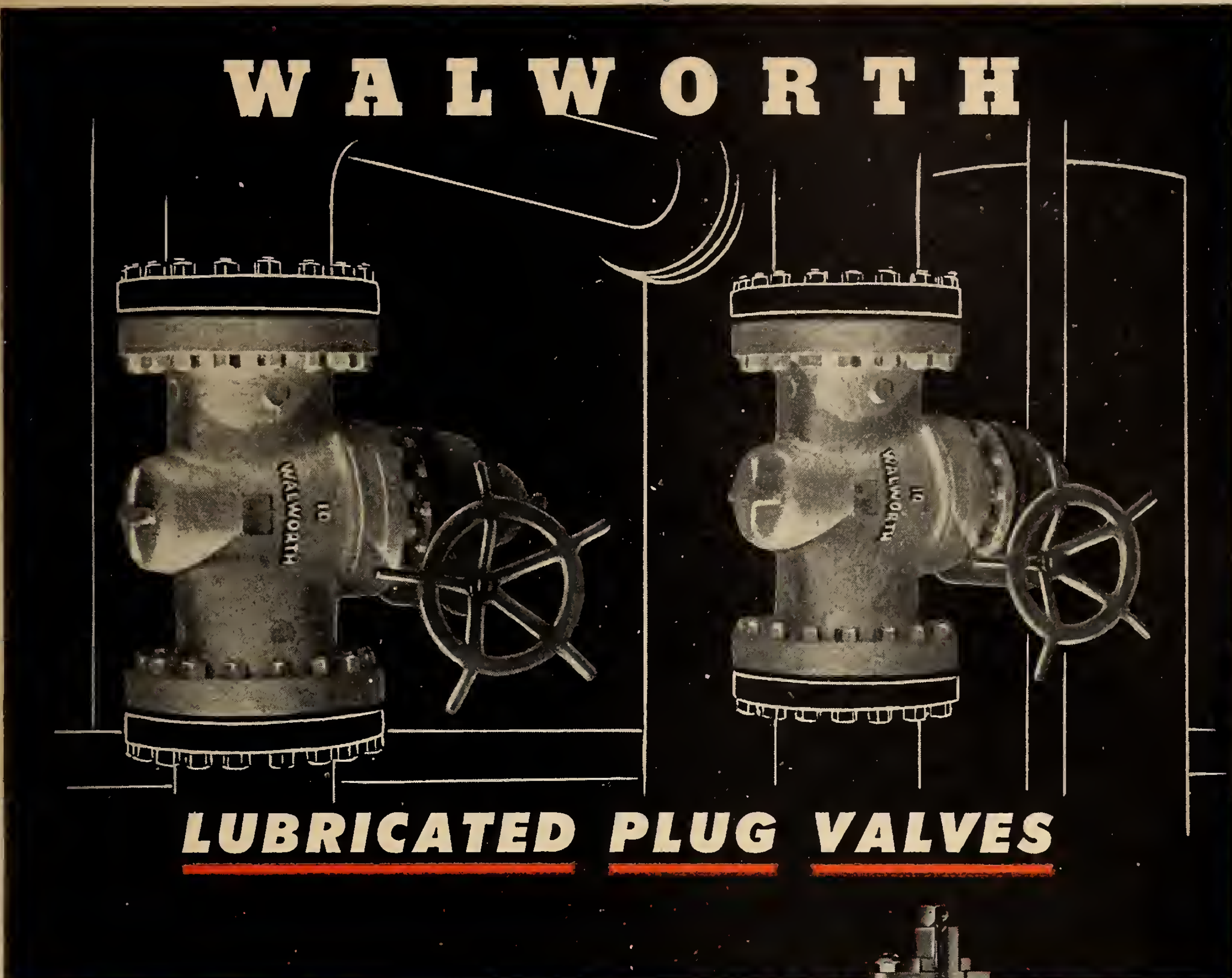
Prior to his military service and during summer vacations Mr. Brown worked with the Canadian Bridge Company Limited as a structural detailer. On graduation he joined the company as an estimating engineer and is presently assistant contracting engineer.

He has already had active participation in Institute activities, serving in various executive capacities includng those of secretary and treasurer.

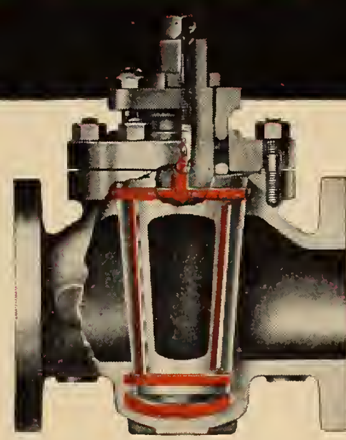
R. J. Wood, JR.E.I.C., of Honeywell Controls Limited has been appointed sales supervisor for the power industry following service with the company since 1951.

He is a 1949 graduate of the Nova Scotia Technical College in mechanical engineering and gained his initial experience with the Canadian Celanese Limited.

R. L. Walker, JR.E.I.C., a civil engineer from the University of British Columbia, class of 1950, has joined the firm of Hunting Technical and Exploration Services Limited, of Toronto. His first assignment will be in Ceylon where he will act in a liaison and co-ordinating capacity in connection with studies of



Better because . . . They are *pressure sealed* with an insoluble lubricant readily renewed while the valve is in service. Lubricant completely surrounds the plug ports assuring a tight seal against leaks. It also insures ease of operation by reducing friction between the body and the plug while at the same time protecting the finished surfaces against corrosion and wear.



Lubricant system of a Walworth No. 1700F Regular Gland, Wrench Operated, Steel-iron, *Lubricated Plug* Valve. Other Walworth *Lubricated Plug* Valves include Single Gland, and Ball Bearing types. Sizes to 30-inches — pressures to 5,000 psi, and for vacuum service.

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DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD the island's water resources under the present Canadian Colombo Plan integrated survey.

Experienced in specialized water resources in Malaya and in Canada Mr. Walker went to his last position as executive assistant to the Fraser River Board in Victoria, B.C. in 1953. In Malaya for three years previous to this time, he was with the Drainage and Irrigation Department of Malaya, engaged in designing and supervising construction of drainage and irrigation projects. While in Johore West he was responsible for the maintenance and operation of a mechanical plant. He was responsible for the collection and collation of hydrometric and meterological data, as well as supervision of a design office and various projects.

R. L. Walker, JR.E.I.C.

O. N. Smith, JR.E.I.C., of Honeywell Controls Limited has been named to the post of sales supervisor of the Montreal Branch, industrial division.

Mr. Smith graduated from McGill University in 1954 in mechanical engineering. With the firm since that time he has been active in sales work in connection with the oil and chemical industries.

K. R. Piekarski, JR.E.I.C., is the president of the newly formed Japan Industrial Equipment Company of Canada Limited, which will specialize in the design, service and sales of heavy industrial machinery and will design custom equipment in Canada for manufacture in Japan.

Mr. Piekarski entered the University of London to study mechanical engineering, in 1945, after having his previous studies at the University of Warsaw broken by five years of capitivity during World War II. On receiving his qualifications at London University he became assistant to the professor of metallurgy. He has also held appointments as design and development engineer for a British firm dealing with precious metals. In 1951 he became head of the metallurgy department of the Ryerson Institute of Technology. Recently he has been engineering manager for MN Automation

K. R. Piekarski, JR.E.I.C.

• PERSONALS

Limited, Canada's only firm of automation consultants.

A. S. La Mothe, JR.E.I.C., has been named engineering manager with the firm of Industrial Maintenance Limited, at Montreal.

Formerly associated with McColl-Frontenac Oil Company Limited, at Montreal, he held the position of construction maintenance engineer, marketing.

He is a MGill University graduate, class of 1950.

T. A. Buckle, JR.E.I.C., of the University of Saskatchewan, class of 1955, is with the Hydro-Electric Power Commission of Ontario at Toronto, where he is at work in the system planning department of the organization.

John W. Gouge, JR.E.I.C., has assumed responsibility as chemical economist, with the Stanford Research Institute, assigned to the Portland office of the organization.

Mr. Gouge is a University of British Columbia graduate, class of 1950 and formerly held the post of market research analyst with the Consolidated Mining and Smelting Company of Canada Limited at Montreal.

C. V. Flanagan, JR.E.I.C., a 1951 graduate of the University of Toronto with a B.A. Sc. degree is employed with the Chrysler Engineering division in Detroit as a development engineer in the fluid dynamics section.

Mr. Flanagan was previously associated with the Dunlop Rubber Company in Toronto as a development engineer.

W. J. Hardy, JR.E.I.C., of the University of British Columbia, class of 1952 is working as an assistant mechanical superintendent in Vancouver where he is with the Canadian White Pine division of MacMillan and Bloedel Limited.

Mr. Hardy gained his initial experi-

A. S. La Mothe, JR.E.I.C.

ence in engineering with the Powell River Pulp and Paper Company Limited at Powell River, B.C., as a mechanical engineer.

E. H. Gilliatt, JR.E.I.C., of the Nova Scotia Technical College, class of 1952, has received the appointment of regional

E. H. Gilliatt, JR.E.I.C.

transportation engineer with the Canadian National Raliways at Moncton, N.B.

Mr. Gilliatt began his career with the C.N.R. as a trainee engineer, research and development department at Montreal. Since then he has been promoted to assistant engineer and assistant transportation engineer, the latter appointment at Montreal in 1955. He returned to Moncton last year and was appointed acting regional transportation engineer a short time later.

G. Gow, JR.E.I.C., has left the Electric Reduction Company Limited, where he has been employed at various centres in Quebec and has accepted a post with the Mersey Paper Company Limited at Liverpool, N.S.

Mr. Gow is a Queen's University graduate in electrical engineering, class of 1950.

H. Roach, JR.E.I.C., of the Harbours and Rivers Branch of the Department of Public Works of Canada has been transferred from Charlottetown to St. John, N.B. In his new location Mr. Roach will serve the French-speaking districts of New Brunswick.

He is a graduate of the Nova Scotia Technical College, class of 1953.

G. Sobering, JR.E.I.C., has been appointed assistant plant manager, car division of the Canadian Car Company Limited at Montreal.

Mr. Sobering who is a graduate of McGill University, was formerly with the

• PERSONALS

Canadian Pratt and Whitney Aircraft Company at Longueil and prior to that was with Ford Motor Company of Canada at Windsor, Ont. He served overseas as a bomber pilot in the R.C.A.F. and is now a member of 438 (F), City of Montreal, auxiliary squadron.

D. J. L. Kennedy, JR.E.I.C., has accepted a post with the University of Toronto, in the capacity of lecturer in the department of civil engineering.

Mr. Kennedy graduated from that University with a degree in civil engineeering in 1951 and has since then been associated with the Foundation Company of Canada at Montreal and with Geocon Limited, Toronto.

W. H. Potts, JR.E.I.C., has accepted a position with the firm of Guildwood Development Limited, Scarborough, Ont.

Mr. Potts, formerly associated with the Electric Reduction Company of Canada Limited at Buckingham, Que., and with Shepherd and Powell, consulting engineers of Toronto, is a graduate of Queen's University, class of 1948.

H. D. Stevenson, JR.E.I.C., of the firm of Robertson-Irwin Limited, has recently been transferred from Hamilton to Vancouver where he continues to be active in the sales and engineering field.

Mr. Stevenson is a University of Manitoba graduate of the class of 1953.

John Westaway, JR.E.I.C., a Queen's University graduate class of 1952 has transferred his professional services from the Canadian Westinghouse Company Limited, Hamilton, Ont. to the Potash Company of America at Saskatoon, Sask.

Wm. A. H. McCorquodale, JR.E.I.C., has accepted an appointment as an electrical engineer with the firm of Sargent, Webster, Crenshaw and Folley, architects and engineers at Syracuse, N.Y. With the Ford Motor Company in Windosr, Ont., for several years, he has also at an earlier date worked with Northern Electric in Montreal. He is a University of British Columbia graduate, class of 1949.

J. S. Howard, JR.E.I.C., who graduated from the University of London, England, in 1956, and who has since then been employed with Dominion Textile Company Limited, Montreal, has transferred his services to the firm of Babcock-Wilcox and Goldie McCulloch, at Galt, Ont.

R. J. Fulton, S.E.I.C., has terminated his employment with the Department of Highways, Province of Ontario and has accepted a position with the Aluminum Company of Canadaat Arvida, Que.

He graduated in civil engineering, class of 1956, at Queen's University.

NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

BROCKVILLE

F. E. TREWARTHA, M.E.I.C.,
Secretary-Treasurer

Annual Report

The Brockville Branch held eight meetings and one tour during 1956. Two of these meetings were joint meetings with other technical groups, one with the Canadian Institute of Chemistry and the other with the local branches of the C.I.C. and the National Association of Corrosion Engineers. Dinner meetings were particularly successful and a total of four were included in the eight meetings held. The total membership of the branch increased from 58 to 69 during the year. With the continued growth of industry in the area it is expected that the branch will continue to grow at a steady rate.

Membership chairman, H. Gilchrist, took on the job of chairman of a professional development committee. It plans to commence a course in January 1957. It is expected that this first venture in running a P.D. course will be successful as twenty-five members have expressed their intention of participating.

Colonel Grant, field-secretary, visited Smith Falls on February 29, 1957 in order to increase the interest in Branch activities in the outlying areas of the Branch. Members of the executive joined in a dinner meeting with members from Merrickville, Elgin, Kempville and Smith Falls.

The 1956 program began with the showing of the film "Leonardo da Vinci" and moved on to the E.I.C.-C.I.C. dinner at which "Current Progress on the St. Lawrence" was clarified by Mr. W. Hogg. In February and March the "Pelee Island Submarine Cable," discussed by Mr. J. S. Waddinton, and the E.I.C.-C.I.C. dinner dance at which Mr. A. S. Proctor of Du Pont delivered an address on "Orlon Acrylic Fibre", comprised the Branch activities. This was followed by an address on the "Cement Industry in Canada" by Mr. Tremaine, and a tour of the St. Lawrence Seaway in May.

Resuming activities late in September members heard a talk on "Corrosion" during the joint meeting held with the C.I.C. and the N.A.C.E. In October, "Geese on James Bay" was presented by Dr. Stearrett. Closing the year's activities Clarence Marshall spoke on "Nation Wide Toll Dialling" in November.

PROFESSIONAL DEVELOPMENT IN CALGARY

Shown below are two of the speakers engaged by the Calgary Branch in their recent professional development meetings held March 5 and 14. The lectures covered the subjects of finance, human relationships, management and self-expression. Dr. Palmer, an internationally prominent management consultant of Los Angeles, Calif., spoke on "How to Motivate the Young Engineer", while T. W. Meredith, manager of the Calgary office of Osler, Hammond and Nanton Limited, a nation-wide brokerage firm addressed the group on "The Investment Industry".

Dr. D. Palmer

T. W. Meredith

BELLEVILLE

E. T. HILBIG, JR.E.I.C.,
Secretary-Treasurer

Joint Meeting I.R.E.

On April 8, 1957 a joint meeting with the local branch of the I.R.E. was held. Guest speaker F. A. Smith filled in for R. G. Griffith, chief engineer of the Canadian Overseas Telecommunication Corporation who was unable to attend. Mr. Smith delivered Mr. Griffith's paper on the construction and installation of the trans-Atlantic telephone cables. The paper was supplemented with slides, some of which were taken aboard the S.S. Monarch during the course of laying the cable.

Keen interest was displayed by all present and an active discussion period followed the talk.

Robert Smith thanked the speaker.

CENTRAL BRITISH COLUMBIA

H. D. de BECK, JR.E.I.C.,
Secretary-Treasurer

Annual Report

Branch meeting attendance this year was not as complete as it has been in previous years. This reflects the growing industrial and construction activity in the British Columbia interior. Most of the engineering professions are overworked due to the shortage of qualified persons. So much time is being devoted to the interests of others that our own are suffering from lack of attention. Each of us must continue to urge our membership now totalling 86, to devote some

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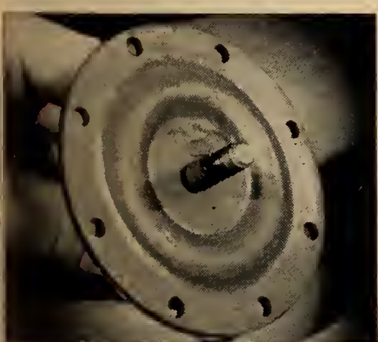
In November, 1954, a Hypalon diaphragm was installed in a proportioning pump in the plant of Fields Point Mfg. Corp. at Providence, R. I. Since that time it has been on continuous service handling 66° Be. sulfuric acid.



Before the use of Hypalon, diaphragms were oxidized and embrittled by the strong acid and had to be replaced every few months.

The diaphragm flexes about 26 times a minute through a ¼-in. stroke and is fabric-reinforced for 125 psi. service. The sulfuric goes from the pump to a stoneware tower where it dries chlorine gas from electrolytic cells.

Hypalon is a new Du Pont synthetic rubber which is noteworthy for its resistance to oxidation—by chemicals, heat, ozone or sunlight and weather. It is being used in the chemical industry for tank lining, acid hose, colored protective coatings, gaskets, valve inserts and pump parts.

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Neoprene lining is still good after a year. The best of several other kinds of linings only last a fraction of this time.

Corrosion of this scrubber once was the No. 1 production problem at the Bessemer City, N. C., plant of Lithium Corporation of America.

The scrubber cleans combustion gases from a long rotary kiln where lithium ore is given an "acid roast." Contaminants in the gas are sulfur trioxide and abrasive dust picked up from the acidified ore. Gases from the kiln pass first through a brick-and-lead-lined precooler; they enter the scrubber at 140° F. and spiral upward through water sprays to be exhausted through a fan and ductwork to a stack.

The original scrubber tank and fan were of plastic-coated mild steel, but abrasives in the gas scoured off the protective film. The fan was recoated and a temporary plastic-lined stainless steel scrubber installed. All failed, as did the stainless steel ductwork, and had to be replaced several times in the first few months of operation.

Finally, sheets of neoprene were applied to scrubber, ductwork and fan — and after a full year of round-the-clock operation, the neoprene-lined equipment was still in good condition. Equipment repairs no longer shut down production, and inexpensive mild steel can now be used instead of stainless.

Abrasion-and-acid-resistant tank linings are only one of many applications for neoprene in the chemical industry. It's used also for its resistance to oils and to weathering, and in the form of hose, belting, shoe soles, maintenance paint, protective clothing, packing, gaskets, diaphragms — any rubber item in the plant. For more information about neoprene, just clip the coupon.

Scrubber cleans combustion gases from rotary ore-roasting kiln.

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time to Branch affairs. However, due to the devoted work done by the executive and by the active membership of the Branch we should consider it a successful year.

Our contacts with the B.C.E.S. have been maintained. The visit of the registrar of the Association of Professional Engineers of B.C. was most welcome. Invitations were made to members of C.I.M.M., from time to time, to attend our meetings.

Meetings during the year 1956 were handled by a joint executive B.C.E.S. and E.I.C. This arrangement has been satisfactory. If at all possible a similar arrangement should continue at least until confederation or some other circumstances bring about a change. Two very topical subjects were brought up for discussions at meetings during the year were the Kelowna Bridge, and Natural Gas Development.

Important Film Shown

The firm "Leonardo da Vinci" was secured from headquarters. This was first shown at a meeting held in Penticton on April 20 when colleagues were invited from the Pacific Northwest Snow Conference. The film was later shown to members at a meeting in Kamloops.

Engineers' Wives

The Engineers' Wives Association, active in Penticton for several years, continues to function. General discussions and talks comprise the programs. An interesting illustrated talk was given by Mrs. Gay, an exchange teacher, recently returned from Great Britain.

The Association acted as co-hosts to the ladies attending the municipal Engineers' Association convention in Penticton, a buffet lunch, drives, and a tea being very much enjoyed. Chairman and secretary of the organization for 1956 were Mrs. W. J. Owen, and Mrs. G. Brockhouse.

HAMILTON

W. A. H. FILER, JR.E.I.C.,
Secretary-Treasurer

J. R. CURRIE, M.E.I.C.,
Branch News Editor

Joint Meeting

The April meeting of the Hamilton Branch was held at Westinghouse Auditorium on April 4, 1957, as a joint meeting with the Hamilton and Toronto Branches of the American Institute of Electrical Engineers. These annual joint meetings were inaugurated in 1919, and have afforded engineers in this area an opportunity of hearing outstanding speakers discuss subjects of current interest.

Guest at the meeting was Dr. W. E. Shoupp, technical director, Commercial Atomic Power Activities of Westinghouse Electric Corporation, who spoke on "Atomic Power Developments". Dr. Shoupp discussed at length the types of reactors and their basic components, and the relationship of the reactor to the steam power and turbine generator systems.

Main plants at Calder Hall, Russia. The main operating atomic power plants to-day are the Calder Hall plants, and the small Russian plants. Dr. Shoupp stated that the large size of atomic power plants would limit their use in the foreseeable future largely to central power stations and military aircraft and ships. Automobiles, trains, and commercial aircraft would continue to use power plants utilizing hydro-carbon fuels. Present indications are the bigger the atomic power plant the better, the ultimate size depending solely upon the development of our knowledge in this new field. At the present time no single type of reactor has shown itself to be the best for all conditions.

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The economic life of a reactor would appear to be from 30 to 50 years, and with costs amortized over this period, power costs should not be excessive. The high cost of reactors at present is partly due to over-engineering owing to the emphasis placed upon safety, but as operating knowledge is acquired, the cost is expected to be reduced. Dr. Shoupp stated that no industry in America has a better safety record than the atomic industry.

In response to a question concerning the disposal of atomic waste, Dr. Shoupp felt that the waste problem had been over-emphasized, and in his opinion there were many barren parts of the world which could be used for storage of atomic waste.

HALIFAX

J. E. REARDON, M.E.I.C.,
Secretary

G. H. DUNPHY, M.E.I.C.,
Branch News Reporter

Guests of Military Engineers

The Military Engineers' Association of Canada have in the past, co-operated with the local Branch of the Institute in holding one of the meetings and extending an invitation to the members of the E.I.C. Accordingly, on March 25, 1957 members gathered at the R.C.E. Armouries to hear R. F. Shaw, on "Construction of the DEW Line." His talk was accompanied by a colour film covering the construction work from the days of the first landing in the Arctic, which pointed out in great detail the problems of communication and transportation that were faced by the contractors on this job. Mrs. Shaw made a running commentary during the showing of the film. A discussion period followed.

The Institute is indebted to Colonel H. Dickson, O.C., R.C.E., and to Captain W. Landry, chairman of the Halifax Branch of the Military Engineers' Association of Canada, who extended the invitation and mess privileges to the members of the Institute.

Colonel Daryl Calkin, president of the Military Engineers' Association of Canada introduced the speaker.

An invitation had been extended to members of the Engineers' Wives Association, holding an annual meeting that evening, to attend. This was enjoyed by a great many.

KITCHENER

A. H. AUSTIN, JR.E.I.C.,
Secretary-Treasurer

President's Visit

Joined by the Grand Valley Group of Engineers, Branch members held a dinner meeting at the Iroquois Hotel on March 22, 1957, to mark the official visit of President V. A. McKillop. Other guests at the affair included Colonel Grant, field secretary of the E.I.C., and L. J. R. Sanders, Dominion Councillor.

In a short address President McKillop dealt with the work of the Institute throughout Canada.

A technical session followed the dinner, in which Don Hamilton of the Dow-Corning Company delivered a paper dealing at length with "Silicones", accompanied by a film giving examples of the uses of silicones in their various forms. In his talk Mr. Hamilton dealt not only with the manufacturing process but also with the uses of the relatively new substances developed during the last war, now totalling 600 types. Uses in insulation for electrical equipment, paint, greases, fabrics, radar, rubber tires, were amply illustrated.

A discussion period was held at the close of the film.

The president's visit opened with a

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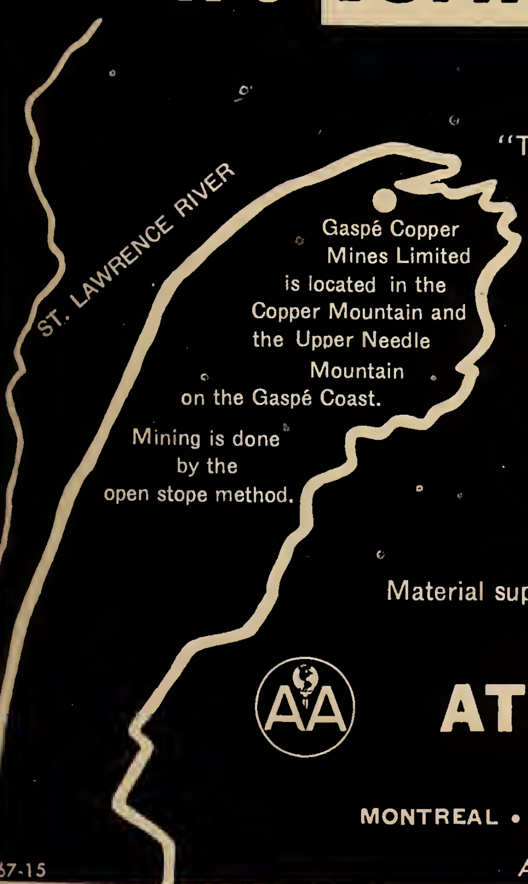

noon luncheon with the executive and their wives, followed by an executive meeting in the afternoon. Mrs. L. J. R. Sanders entertained the ladies. For picture see page 908.

KINGSTON

D. I. OUROM, JR.E.I.C.,
Secretary-Treasurer

Prof. W. B. Rice Speaks

The Kingston Branch of the Institute gathered at Queen's University, Kingston, on March 19, 1957 to hear Professor W. B. Rice, deliver a paper on the subject of metal cutting research. In examining the current theories of metal cutting Prof. Rice gave a description of the experimental investigations which are in progress in the Department of mechanical engineering at Queen's University.

On Tuesday, April 16, 1957, R F. Legget, director of the division of building research with N.R.C., Ottawa, and E. G. Swenson, associate research officer in charge of concrete research addressed the Kingston Branch on the topic of "Concrete Problems in the Kingston Area". Under discussion was the progress made in regards research being carried out on concrete used in the Kingston area.

The concrete used in this area has been found to be subject to unusual cracking tendencies, evident in sidewalks about the town. N.R.C. is carefully pursuing an investigation into this phenomena. Measures showing promise of providing good performance were discussed.

LETHBRIDGE

R. D. HALL, JR.E.I.C.,
Secretary-Treasurer

R. J. GARDINER, JR.E.I.C.,
Branch News Editor

"Hidden Power"

A dinner meeting was held in the banquet room of the El Rancho Restaurant March 16, 1957. About 35 members present enjoyed an excellent dinner, followed by an informative film entitled "Hidden Power". It provided an inside view of operations carried on at Canada's Chalk River atomic energy plant, and the peaceful use of atomic energy.

Musical entertainment was provided by Brown's orchestra. George Brown led community singing. Vocal selections were given by Art Hunt.

KOOTENAY

J. L. P. LIMBERT, JR.E.I.C.,
Secretary

G. T. J. HUGHES, M.E.I.C.,
Branch News Editor

Supper Meeting at Trail

A supper meeting was held at the Crown Point Hotel, Trail, on April 10

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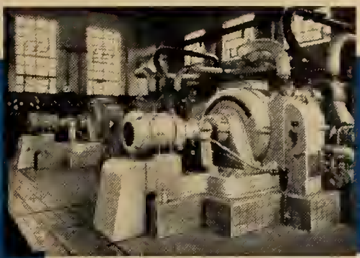

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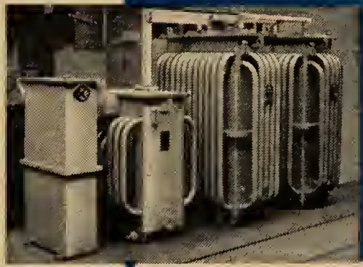

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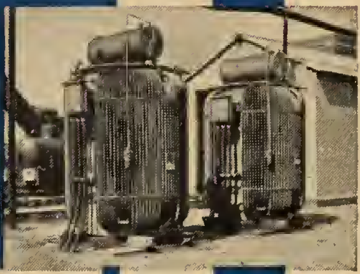

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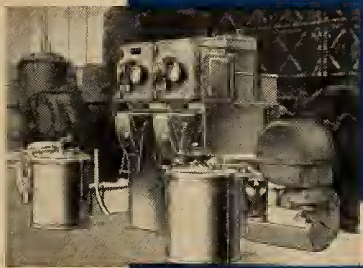

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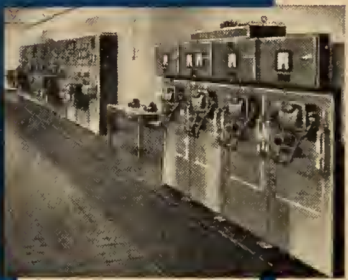

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to welcome Dr. J. G. Stewart, B.A., M.A., Ph. D., District Co-ordinator of Testing and Counselling for Trail School District No. 11, as guest speaker.

Dr. Stewart drew upon his immense psychological experience to explain to members the four types of personalities, and examined in turn the outlooks of the idealist, the realist, the naturalist and the pragmatist. The engineer, he felt, was generally in the realist class.

In his own detailed study of 450 students over a period of twenty years as counsellor, Dr. Stewart revealed that over 50 per cent felt that they had been wrongly advised in their choice of a career. He maintained that our economy could only support 7 per cent of the population as professional workers, yet the total number of students today, if successful in their studies, brought this figure to 67 per cent.

President McKillop chats with the Kitchener Branch executive during his March visit. Standing are, l. to r.: L. J. R. Sanders, Dominion counsellor; A. H. Austin, Branch secretary; and Col. Grant, field secretary of the Institute. Seated, John Runge, Branch chairman; Mr. McKillop, Walter Runge, past-chairman, and M. A. Montgomery, vice-president of the Institute.

NIAGARA PENINSULA

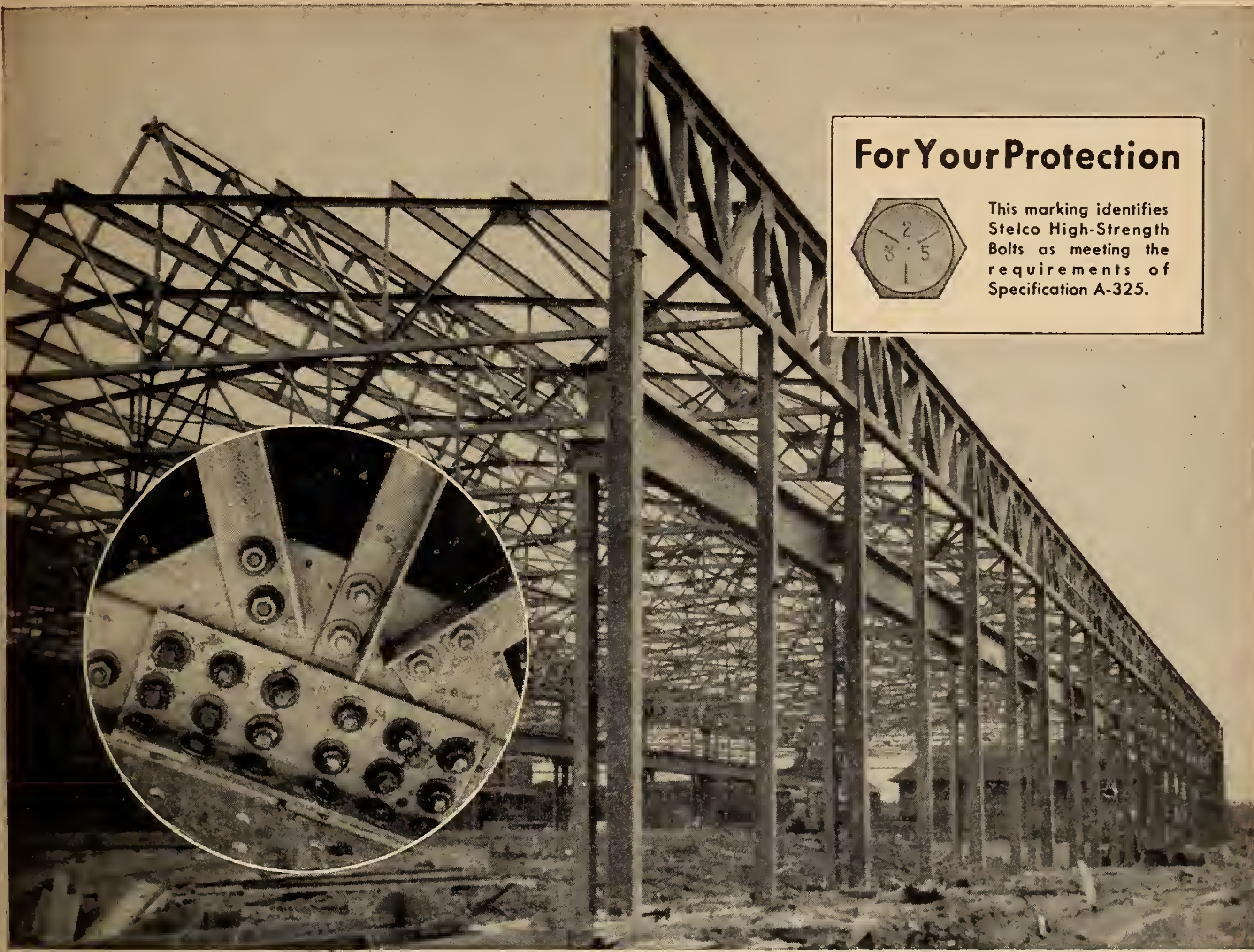
P. A. SALDAT, JR.E.I.C.,
Secretary-Treasurer

B. H. CHICK, JR.E.I.C.,
Branch News Editor

A tour of the mill at the Ontario Paper Company Limited plant at Thorold, Ont., was held on January 17, 1957.

Gordon Franklin, head of the Ontario Paper Company Control Department, chemical and instrumentation, discussed recent developments in research; Gordon Sutherland, mechanical engineer described in detail the process of papermaking; and Carl Hand, electrical engineer, spoke of paper machine drive control and electrical distribution in paper mills. A discussion period followed.

Talk on films and Transistors. The February meeting was held at Welland, Ont., on February 21. Guest speaker was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• BRANCH NEWS

C. L. Roach, staff engineer of the headquarters engineering department of the Bell Telephone Company, who presented an illustrated talk on "Transitors" and related devices. He also dealt with the fundamental solid state concepts which conveyed an appreciation of how these new devices are operated.

A buffet lunch followed the meeting. *Professional Development Papers Presented.* On March 21, 1957, a meeting at Niagara Falls was highlighted by the presentation of papers by four members of the Professional Development course. F. R. Denham spoke on, "A New Type of Heater," H. J .Wilkinson discussed, "The Concrete Shell." D. P. Fernandes dealt with "Applications of Correlation Analysis, " and D. A. Buchanan presented a paper entitled, "Patents, Trade Marks, and Copywriting."

The Branch prize for the best paper went to F. R. Denham. Mr. Little presided as chairman of the meeting.

NIPISSING AND UPPER OTTAWA

G. R. KARTZMARK, JR.E.I.C., *Secretary-Treasurer*

J. W. MILLAR, M.E.I.C., *Branch News Editor*

Film and Demonstration

The monthly dinner meeting of the Nipissing and Upper Ottawa Branch of the Institute was held Wednesday, April 3, 1957 with presiding chairman T. C. Macnabb. Excellent attendance, particularly from Sturgeon Falls and Temiskaming was noted.

The feature of the evening was a film and demonstration presented by Fred N. Walsh and R. J. Armstrong, representatives of the Plywood Manufacturers Association of British Columbia. The film dealt with the manufacture and uses of plywood, particularly douglas fir plywood. The members were shown the cutting of huge trees in the west coast forests, the preparation of the logs before entering the mill, the log inside the mill being peeled or cut into long sheets of veneer, the processing of the veneer, the gluing and pressing of the sheets of veneer into plywood and finally the finishing and packaging of plywood for shipment.

The film also showed the multitude of uses of plywood, from the forms for pouring concrete in huge construction projects, to a feeder for hogs, or a smart kitchen cabinet. Plywood is of great value in the building trade as it speeds assembly and assures strong and rigid construction.

Mr. Walsh and Mr. Armstrong boiled plywood in water, chopped it, drove nails into it, bent it, hammered it and ably proved that plywood will resist splitting, has greater resistance to bending than ordinary wood and that the glue used to bond the laminations is actually waterproof.

A question period followed the film and demonstration. The number of questions indicated the great interest of the members in plywood and its special properties.

Election of Officers

The monthly meeting and annual election of officers of the Branch was held at White Oaks Inn, Temiskaming, on May 1, 1957.

Following dinner the annual reports of committees were read and the following slate of new officers elected for the ensuing term:

Chairman, J. F. Chantler; vice-chairman, J. S. Cooper; executive committee (two year term) — R. S. MacLennan,

Head table guests shown enjoying the dinner meeting of the Nipissing and Upper Ottawa Branch in March, honouring President McKillop, and reported in the May issue of the *Journal* are shown below. Left to right are: J. S. Cooper, councillor; Mrs. Cooper; J. F. Chantler, vice-chairman; Mrs. McKillop; the president; Mrs. Macnabb; and T. C. Macnabb, chairman.


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North Bay; P. Rebin, Sturgeon Falls; J. Warburton, Temiskaming; and H. Staniforth, of Kiosk. Executive committee members with one year still to run are: — E. A. Watson, North Bay and J. Crothers, Temiskaming. The retiring chairman is T. C. Macnabb.

Brig. Quilliam Guest Speaker

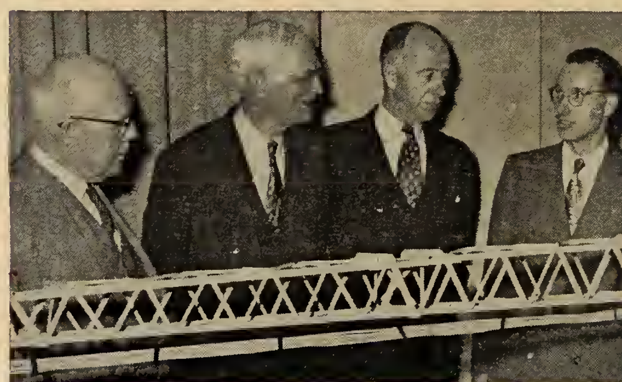
Brigadier C. D. Quilliam, O.B.E., of Kingston who lived for many years in the Middle East, drew on his knowledge of the Arab Nations in his talk to the Branch.

A native of Ireland, he took part in World War I and during the next thirty-two years served in Turkey, India, the Arab countries, Egypt and the Sudan. In World War II he held the post of chief of political intelligence in the Middle East and in the Balkans.

Brigadier Quilliam traced the course of the Arab nations from the time they were part of the Turkish Empire and then broken up and divided after World War I. Considering Israel rightfully theirs, the establishment of a national home for the Jews in Israel has proved not acceptable.

An Arab problem would always exist, he felt, and the creation of a third major

Third year engineering students of St. Francis Xavier University examine a scale model of a ship fender at New Glasgow, N.S.



Members of North Nova Scotia Branch examine cable arm of model fender at New Glasgow, N.S. L. to r.: J. Cavanaugh, general manager, Malagash Salt Co.; D. Dunbar, Branch sec.-treas.; D. J. MacNeil, chairman; R. Morrow, chief engineer, Maritime Steel and Foundries Ltd. **See report p. 914.**

bloc, including the Middle East, Arab Nations, and Africa would be attempted. He said Col. Nasser was a strong man with a mission, but that he would probably not last more than four or five years. The Arab Nations have little in natural resources and poverty is general. In fact the individual has little to lose and is ready to follow the mob.

NORTH NOVA SCOTIA

D. G. DUNBAR, M.E.I.C.,
Secretary-treasurer

Branch Host to Students

On March 8, 1957, the third year engineering students of St. Francis Xavier University were the guests of the Nova Scotia Power Commission on a lecture-tour of the Commission's plants in Stellarton and Trenton, Nova Scotia.

Later, on that date the North Nova Scotia Branch made arrangements to show the students a scale model of the fenders that will be used in the locks along the St. Lawrence Seaway. This model was constructed by the Maritime Steel and Foundries Limited of New Glasgow, and it was through the courtesy of its president, Clyde Cameron, M.E.I.C., that it was made available on this occasion. Maritime Steel and Foundries Limited will build the fenders required in the seaway locks. The model was explained to the students by Robert Morrow, M.E.I.C., chief engineer for the company.

Following the examination of the fender model the students were guests of the North Nova Scotia Branch at a luncheon served in the dining-room of the Norfolk Hotel, New Glasgow.

OTTAWA

W. V. MORRIS, M.E.I.C.,
Secretary

ARTHUR H. GRAVES, S.E.I.C.,
Publicity Committee

Sir Claude Gibb

Sir Claude Gibb's address to the Ottawa Branches of the E.I.C. and the A.I.E.E. at the Chateau Laurier on April 4, 1957 was considered one of the most successful luncheon meetings held this year. Indicative of this was an attendance totalling 160 persons.

Sir Claude was introduced by Lorne Gray.

At the conclusion of his address, which was entitled "Some Engineering Problems in Connection with the Development of Nuclear Energy," a vote of thanks was tendered him by Colonel W. A. Capelle.

A full-scale press conference was held one hour prior to the luncheon meeting with reporters from the three local newspapers present.

Head table guests at the affair were, as follows: Lorne Gray, vice-president of the Atomic Energy of Canada Limited; J. H. Parkin, director of mechanical engineering at N.R.C.; L. N. Moore, chairman of the Ottawa Branch of the A.I.E.E., A. M. Brown, vice-president of C. A. Parsons of Canada Limited; Sir Claude Gibb, guest speaker; Colonel W. B. Pennock, immediate past-chairman of the Ottawa Branch, and Colonel W. A. Capelle, chairman of the Ottawa Branch.

Ottawa Wives—Tenth Annual Meet

On Tuesday, April 30, 1957, the tenth annual meeting of the Engineers' Wives Association of Ottawa was held at Chateau Laurier with 142 of the total membership of 220 in attendance.

Outgoing president, Mrs. S. L. Gertman presided over the affair. An outstanding part of the meeting was that the ten past-presidents attended, the first of whom was Mrs. K. M. Cameron, wife of a past-president of the Institute. Mrs. Cameron founded the association ten

engineered for the job!

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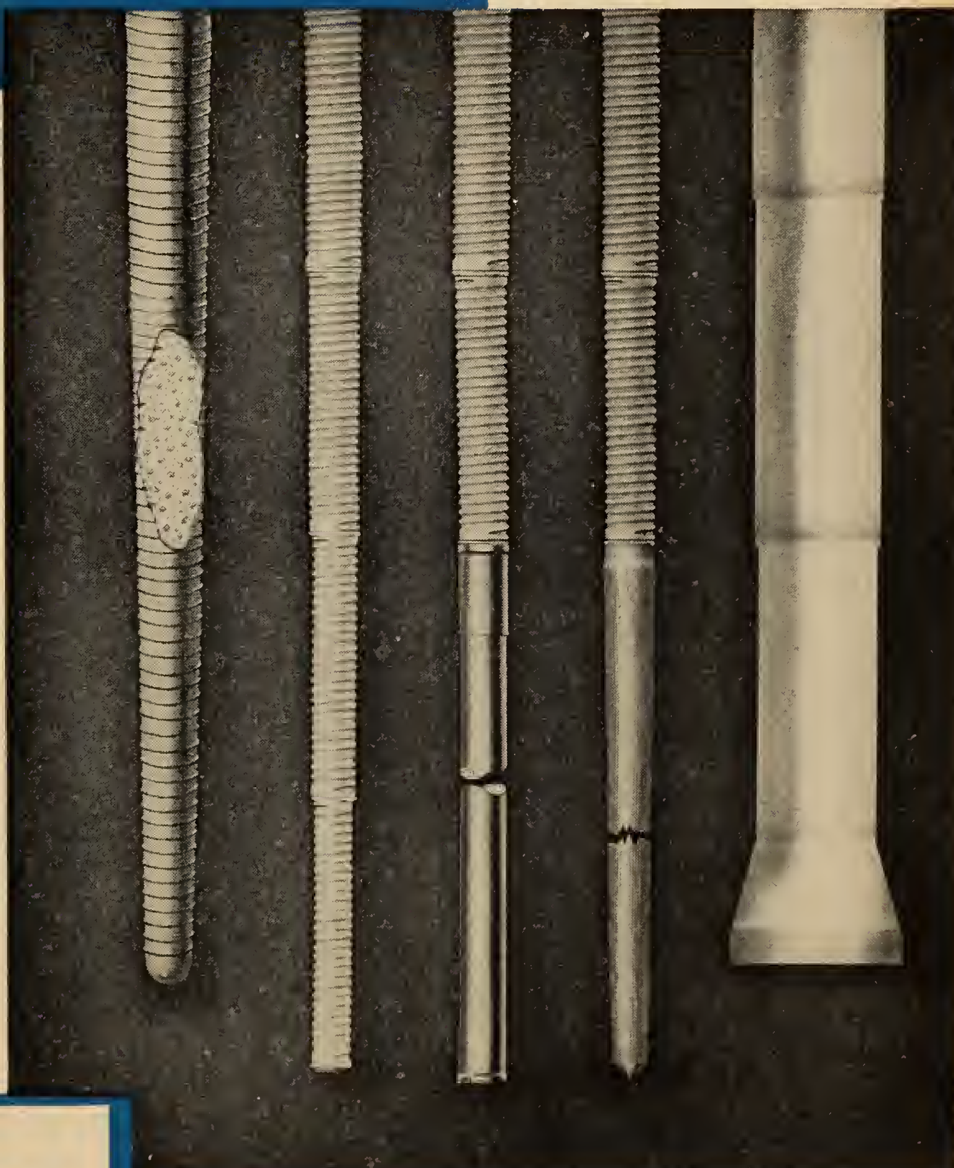

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AROUND THE WORLD — FOUNDED 1897

years ago. She also cut the mammoth birthday cake ordered for the occasion.

Mrs. Gertman, in her report listed the high-lights of each of the ten years. This made a most interesting and impressive list of accomplishments, especially the story of the fund which the Association is accumulating to establish a scholarship, now in excess of $5,000. Two luncheons are held each year, in September and in April, to mark the opening and closing of the season. Monthly teas are held for the express purpose of welcoming newcomers to the organization. In December 1956, the annual tea held for the wife of the president of the Engineering Institute was held for Mrs. McKillop, was very well attended. This has always been one of the most popular events of the year's program. The big money-maker, the February fashion show, last year netted over $700. It was convened by Mrs. L. J. Weeks, incoming president.

Total receipts for the year ending March 31, 1957, were more than $3,000.

Primarily Social. Although the group's activities are primarily social, a certain amount of welfare work is also undertaken. Voluntary assistance is given the community by members who assist at the Cancer Clinic, staff the Snack Bar at the Civic Hospital two days in each week, and assist in the Poppy Day Campaign.

Following luncheon Mrs. Lillian Robertson, of the Field Office, of the Engineering Institute, at Toronto, spoke briefly on the proposed national organization of Wives' Associations which will be discussed at the Annual Meeting of the E.I.C. at Banff in June.

Reports on Gana. Mrs. Prudham, wife of George Prudham, Minister of Mines and Technical Surveys, who represented the Canadian Government at the recent ceremonies connected with the formation of the new state of Gana, spoke of the visit they had made and of the ceremonies attended.

Activities for the season were later brought to a close with a bus tour of the St. Lawrence Seaway project.

SASKATCHEWAN

R. BING-WO, M.E.I.C.,
Secretary-Treasurer

W. G. MACKAY, M.E.I.C.,
Chairman, Saskatoon Section

Saskatoon Section Annual Meeting

The annual meeting of the Saskatoon Section of the Saskatchewan Branch of the Engineering Institute was held on February 27, 1957. The report of the annual meeting of the Branch, held in Regina on February 15 was read by Chairman W. G. McKay. W. R. Staples presented the Union Committee report. B. Torchinsky, secretary-treasurer of the Saskatoon Branch, gave the financial and activities report. Newly elected members of the Saskatoon Section are as follows: Chairman: W. G. McKay; secretary-treasurer: R. E. Ludwig, Program Committee, G. Handegord, D. Strayer, C. M. Thompson, and F. Catterall. Publicity will be handled by R. Dupuis. The student representative chosen was R. Hanson.

Student's Paper Night

The Student Papers Night made up the technical portion of the evening. T. MacDonald of the mechanical engineering department, of the University of Saskatchewan, conducted the presentation of these papers. The Student Papers Night was made possible by the grant of $100.00 from E.I.C. headquarters. Funds were made available to the students to assist in the preparation of slides or charts for the presentation of their subjects. The papers, all given by fourth year students were; "Bearing Materials in Boundary Lubrication," by L. E. Torfa-

son, mechanical engineering; "Abandonment of Gas Wells in the Medicine Hat Field," by L. Larson, civil engineering; "On Top of The World", a discussion of Arctic conditions by L. Morrison, geological engineering; and "Cermets" by F. D. Freidrich, mechanical.

Judges were: Prof. C. Forsberg, E. Cole, and D. Carroll. Prizes as follows: First prize, $25.00 was awarded to L. Morrison. The Second prize, of $15.00, went to F. D. Freidrich, while consolation prizes of $5.00 each were presented to L. Torfason, and L. Larson.

A very successful meeting from the viewpoint of students and members alike, thanks were conferred on the latter for their excellent and well-prepared papers by Vern Freibel.

Sir Claude Gibb's Visit

When Sir Claude Gibb arrived in Regina on April 9, he was met at the airport by Mr. R. R. Keith, M.E.I.C., power production superintendent of The Saskatchewan Corporation and lunched at the Hotel Saskatchewan with vice-chairman of the Branch J. C. Traynor, and a few other members of the Branch, notably engineers of The Saskatchewan Power Corporation.

In the afternoon, Sir Claude held press and television interviews, the latter being for delayed release in an evening newscast and again on a week end news review of important local events.

A private dinner was tendered in Sir Claude's honor in the Hotel Saskatchewan that evening by The Saskatchewan Power Corporation. D. Cass-Beggs, general manager of the Corporation was chairman of the dinner. The dinner was an informal affair, and Sir Claude gave a brief talk to those present. Among the invited guests present were Hon. T. C. Douglas, premier of Saskatchewan and E. J. Durnin, president of the Dominion Council of Professional Engineers.

Sir Claude's lecture was held in the auditorium of the Museum of Natural History. Of the 200 members and guests present, the latter included high school science teachers, college students, members of The United Services Institute, and members of the Armed Forces, active and reserve.

Delivered in a forceful and interesting manner the talk was illustrated with well prepared slides. Sir Claude was a very able speaker, having held the intense attention of the audience throughout the lecture. His talk was interspersed with humour, which added spice to a highly technical subject.

Members agreed that this was one of the best papers ever presented to this Branch. A vote of thanks was moved by Mr. H. I. Nicholl.

TORONTO

D. S. MOYER, JR.E.I.C.,
Secretary-treasurer

A. C. DAVIDSON, M.E.I.C.,
Branch News Editor

Computers Discussed

The Toronto Area Joint Committee of the Engineering Institute, the Institution of Civil Engineers and the American Society of Civil Engineers had for their speaker on March 7, Dr. R. F. Johnston, Director, systems engineering, of Adalia Limited, Montreal, who spoke on the subject: "Electronic Computers and the Civil Engineer".

Dr. Johnston began by outlining some of the applications of computers generally. Business employs computers to give information on hiring and firing of employees, the giving of bonuses, financial programs, routine payroll and similar operations. In the industrial field the most spectacular application is automation. Machines are even able to reproduce themselves without human intervention.

Three Important Features — The kind of computer that the Civil Engineer will most likely be concerned with has three important features. It must be able to follow long and complicated instructions, have large capacity storage, and operate at high speed. The digital computer has these features, and possesses other desirable characteristics. These are: (1) Allowing instructions to be fed in once. (2) Ability to do the basic operations of arithmetic. (3) Ability to transfer instructions, and (4) control. Such a computer requires a small input and a small memory, and a large computer, in distinction to that used in business, which has a small computer, but a large amount of data coming in and going out.

Rentals — Since computers are expensive to buy the practising engineer should learn about rental possibilities. Doing problems on computers breaks down into four phases: Analysis, programming, set-up and running time, and final analysis of results. Analysis and programming may be done by the customer, and will range in cost from $500.00 to $5,000.00. The machine rental will vary from $25.00 to perhaps $400.00 per hour, and must be done by the staff of the calculator. Analysis and interpretation of the results are done by the customer. At present there are three computers in Canada, one each in Toronto, Ottawa, and Montreal.

Dr. Johnston closed by describing some typical problems which a computer can do. It can for example, do traffic control studies which measure truly the capacity of a given length of highway, or compute and compare the stresses in a framed structure with allowable

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stresses, listing only the stresses which are over the allowable.

Programming time may be longer than the computing time, a point which should be kept in mind.

The modern computer can do iteration, transform, invert, relax, but it cannot "glance" at information. The relaxation method is an example of this latter feature. The machine must relax each part of the algorithm, it cannot examine the solution as far as it has proceeded, and take the largest residual to start the next step as a human being can do. With this thought it is comforting to feel that the machine has not yet quite replaced man.

WINNIPEG

C. S. LANDON, M.E.I.C.,
Secretary-Treasurer

Power Agreement Paper

The electrical section of the Winnipeg Branch met at the Canadian Westinghouse Auditorium on March 7, 1957, to hear a paper by C. G. Mills, load control engineer for the Manitoba Hydro Electric Board, entitled "The Manitoba Utilities Power Agreement".

Mr. Mills traced the growth of electricity supply in Winnipeg and the province of Manitoba from the earliest beginnings, through the events which culminated in the Manitoba Utilities Power Agreement. The basis of this Agreement, with particular reference to the methods of making charges for power, was discussed in some detail.

Executives of the Manitoba Utilities, who were present at the meeting, took advantage of the opportunity to thank Mr. Mills for the part he played in solving the complex problems associated with this Agreement. The Utilities in turn were congratulated upon the spirit of co-operation which made the Agreement possible.

Turbines for Commission

On April 4, 1957 the Electrical Section held a joint meeting with the Institute of Power Engineers at the Canadian Westinghouse Auditorium. The speaker, D. F. Abel, turbine sales specialist, Canadian General Electric Company, presented a paper "Large Gas Turbines for the British Columbia Power Commission". The paper was originally presented by A. O. White of the General Electric Company, Schenectady, New York.

When the B.C. Power Commission plant goes into service it will be the largest gas turbine installation in the world. Mr. Abel discussed the plant layout in general and the turbines themselves in some detail. He also discussed the operational conditions and other factors which led to the choice of this plant.

News of Other Societies

Sixth Commonwealth Congress

It is expected that the Sixth Commonwealth Mining and Metallurgical Congress will be the most important and the most comprehensive event yet sponsored by the Canadian mining industry. An estimated 500 traveling delegates from all parts of the world are expected to arrive at Vancouver, B.C., on September 8, 1957, and to travel across Canada by plane and train on a schedule calling for the final meeting at Halifax, N.S., on October 9.

With the approval of the Commonwealth Council of Mining and Metallurgical Institutions, and on the invitation of the Canadian Institute of Mining and Metallurgy, the Sixth Congress will be held in Canada in September and October.

Many delegates will be representatives of interested government agencies and institutions not affiliated with the Commonwealth Council. The General Committee is also encouraging participation by local residents at centres on the route. Thus several thousands of Canadian technical, industrial and government personnel will have an opportunity to take an active part.

The Congress provides an opportunity for the mining industry to tell its story to an interested and receptive international audience.

Among the main features on the program of the Sixth Congress are: a cross-Canada tour from Vancouver to Halifax by chartered trains; an aerial tour of Northern British Columbia, Yukon, Northwest Territories, Northern Saskatchewan and Manitoba; inspection visits to more than 50 major centres of industrial operations including, metal mines, coal mines, smelters and refineries, petroleum and natural gas wells, oil refineries, chemical and petro-chemical plants, steel plants, and other places of professional, technical and historic interest.

Major meetings of the Congress will be held at Vancouver, Edmonton, Winnipeg, Toronto, Ottawa, Montreal, Quebec and Halifax.

Primary and radius tours will take delegates to mining, metallurgical and related operations at: Kitimat, B.C., Whitehorse, Elsa and Dawson, Y.T., Yellowknife, N.W.T., Beaverlodge, Sask., Lynn Lake and Flin Flon, Man., on the northern aerial tour; Trail and Kimberley, B.C., the Crow's Nest Pass area; Banff, Lake Louise, Calgary and Edmonton, Alberta; Saskatoon, Sask., and Winnipeg, Man., on the western rail tour; Steep Rock, Sault Ste. Marie, Blind River, Sudbury, Falconbridge, Timmins, Kirkland Lake, Noranda, Val d'Or, Toronto, Welland, Niagara Falls, Ottawa, Montreal, Quebec, Thetford Mines, Asbestos, Bathurst, Newcastle, Sydney and Halifax on the central and eastern rail tour. Aerial radius trips will be made to the iron mines of Northern Quebec and to Newfoundland.

Five technical volumes on various aspects of the mineral and metal industries in Canada are being prepared as a feature of the Congress by Technical Divisions of the Canadian Institute of Mining and Metallurgy.

The honorary president of the Sixth Congress is The Right Honourable Louis S. St. Laurent. The president is R. W. Diamond, of Trail, B.C., Authority for planning and direction of the Sixth Congress is in the hands of a General Committee, whose chairman is Robert A. Bryce, president of Macassa Mines, Ltd., Toronto. Co-chairmen of the general committee are H. L. Roscoe, Toronto, and H. R. Banks, Ottawa. The executive secretary is C. H. Mitchell, 507-837 West Hastings St., Vancouver 1, B.C.

Pile Load Investigation

Records of pile loading tests are urgently required by the Joint Committee on Pile Driving of the Institution of Civil Engineers in Great Britain. This Research Committee is gathering data so that a better method of assessing the ultimate bearing capacity of piles can be established. Useful information is invited from any country to assist in this major research program.

In Canada, the Associate Committee on Soil and Snow Mechanics of the National Research Council will assemble all Canadian information, and transmit it to the Institution. To assist in the recording, a questionnaire has been prepared. It contains a detailed explanation of the study. Copies of the questionnaire are available from W. J. Eden, secretary, Associate Committee on Soil and Snow Mechanics, N.R.C., Ottawa.

Canadian engineers and contractors are encouraged to participate in making a useful contribution to this investigation. The Associate Committee will keep in touch and hopes to make results available when they are ready.

Calendar

Mining

The summer meeting of the Institution of Mining Engineers (England) will be held at Newcastle-on-Tyne, on July 24-26, 1957.

Civil Engineering

For the first time, the American Society of Civil Engineers (33 West 39th St., New York 18, N.Y.) will hold a commercial exhibit in connection with its national convention. A civil engineering show will complement the technical program of the annual meeting at the Hotel Statler, New York City, October 14-18, 1957.

Mechanical Engineering

The Institution of Mechanical Engineers (1 Birdcage Walk, Westminster, London SW 1, England) is arranging a Conference on Lubrication and Wear, to take place October 1-3, 1957 in London.

Library Notes

Additions to the Institute Library

Reviews, Book Notes

Standards

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

AMERICAN INSTITUTE OF PHYSICS HANDBOOK

This handbook is the first American publication of its kind to be exclusively devoted to physics. The increasing amount of specialization within this field, the result of modern research and technical development, has added tremendously to the number of areas encompassed by the subject. Much of the information compiled in this publication would otherwise be scattered in various sources, although only the most generally useful data has been included. The eight main sections of the book cover: mathematics; mechanics; heat; sound; electricity and magnetism; optics; atomic and molecular physics, and nuclear physics. Each of these contains numerous sub-sections individually compiled by a specialist. Topics included that are not readily available elsewhere are: geophysical data; rheological data; flow of gases; shock waves; cross sections, fission products, health physics and mesons; properties of paramagnetic salts; high pressure effects; electronic constants in the low temperature heat capacity of metals; low temperature thermal conductivity; and others. The tables are well prepared and some bibliographies are included. This is a useful reference work for anyone using physics in research, application or teaching. D. E. Gray, ed. Toronto, McGraw-Hill, 1957. Irreg. paging, $18.00.

Members may borrow the books mentioned in these notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS
Monday to Friday
9 a.m. — 5 p.m.
Saturday 9 a.m. — 12 noon.

ANTENNAS

Dealing with both the theoretical and practical aspects of antennas, the topics covered in this publication are: fundamental antenna principles; basic antenna types; input impedance and radiation resistance, ground effects; variations of electrical length by loading; gain and directivity; driven and parasitic arrays, various types of long wire antennas; feeding and matching principles, and several variations on the basic dipole design used in current antenna types. A. Schure, ed. New York, Rider, 1957. 79p., $1.50 (U.S.).

AUTOMATION IN BUSINESS AND INDUSTRY

Based on an extension course given by prominent engineers and scientists at the University of California, this book reviews the status of developments and applications in the field of automation at the time, Spring 1955.

The course was organized to show how the various fields of feedback control theory, instrumentation, analog and digital computation, and data processing are becoming integrated as automation is more widely applied.

Special emphasis was placed on those applications of control systems which can perform both complex control functions and data processing, and considerable attention was paid to electronics, computers, and data processing.

References for further reading are given in many chapters. E. M. Grabbe, ed. New York, Wiley, 1957. 611p., $10.00.

AUTOMATION: ITS PURPOSE AND FUTURE

The author reviews here the progress of automation to date in various fields: engineering, chemistry, the petroleum industry, accounting, transport, stores, food, weapons and translation.

He describes the principles of the digital computer, and discusses the speed with which automation is likely to spread in different countries, and expresses his opinions on the effect of automation on men's lives. Magnus Pyke. New York, Philosophical Library, 1957. 191p., $10.00 (U.S.).

BUILDING AN ENGINEERING CAREER, 3D ED.

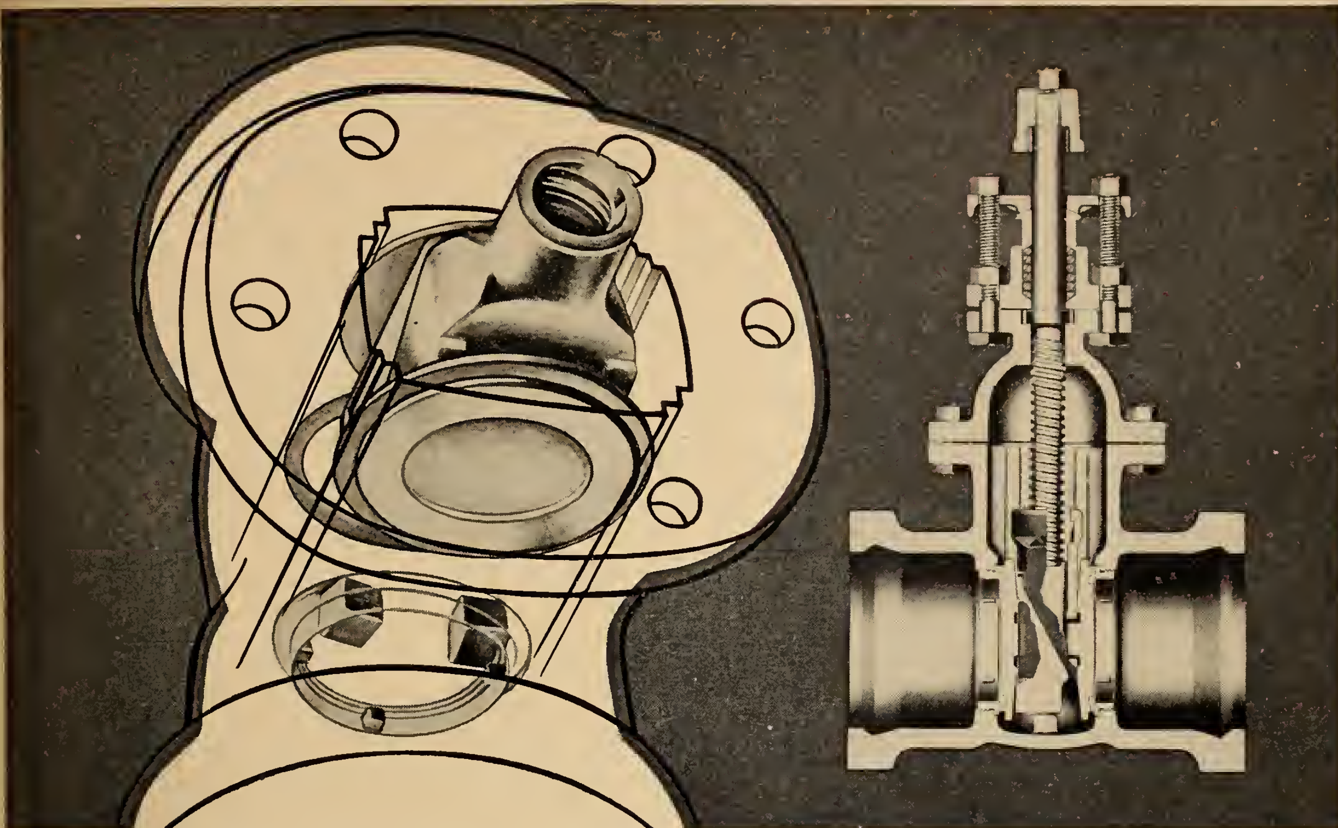
The necessity for orienting the engineering student in the matter of his studies, his future career, and the role of engineering in society has generally been recognized by most instructors. The scope of this book is such that, with mature supervision and direction, it will meet this need.

The three main sections are: education for engineering; historical background of engineering; achievements in engineering. The structure of engineering education is explained, the necessity for learning the basic subjects, and efficient methods of studying technological material. A historical survey of the development of the profession is given, concluding with recent developments and the present importance of engineering in all its fields. Engineering ethics are discussed throughout, and the quantitative and creative nature of the engineer's mode of thinking is explained. Correlated with the latter is a section containing problems. An up-to-date list of visual aids is also included. C. C. Williams and E. A. Farber. Toronto, McGraw-Hill, 1957. 299p., $5.70.

CHEMICAL ENGINEERING REPORTS, 4TH ED.

From the number of enquiries received regarding the best way in which to prepare and write a technical report, we would imagine that this new edition of Professor Kobe's book on preparing a report will be widely welcomed. Although applying specifically to chemical engineering reports, much of his information is equally applicable to other engineering fields, and the book could be profitably read by the majority of engineers.

The author has presented his material in the form of a formal engineering report, and covers searching the available literature, and assembling the findings, emphasizing the importance of



THE OUTLINE drawing shows how the simple, 4-piece disc assembly is held in alignment by the guide ribs. As the disc assembly descends on the stem, the lower spreader strikes a boss in the body. Further closing movement exerts pressure on the spreaders in a wedging action, forcing the parallel discs tightly against the seats.

New Crane disc assembly and guide rib design improve efficiency of AWWA valves

Hub End Valves—No. 480½

Flanged End Valves—No. 2485

Mechanical Joint End Valves—No. 2487½

Two design features—a simple, 4-piece disc assembly and a unique guide rib design—function together to make Crane's new AWWA double-disc gate valves a wise choice for mains and distribution lines.

The double-disc assembly, held in close alignment by the new guide rib design, cannot jam or become disengaged in service. The trunnion-mounted discs are free to rotate as they are raised or lowered, preventing concentrated wear on both discs and seats. And, the rotary motion of the discs tends to clean the seating areas.

The new Crane double-disc gate valves meet all AWWA specifications—and more! For example, the 2-piece gland and gland flange with ball type joint is well-known for preventing stem binding even though uneven pull-up may be applied on gland bolts.

These quality AWWA valves are available in sizes from 2″ to 12″. Conforming to AWWA specifications, they are bronze-trimmed and have non-rising stems. For complete specifications, write:

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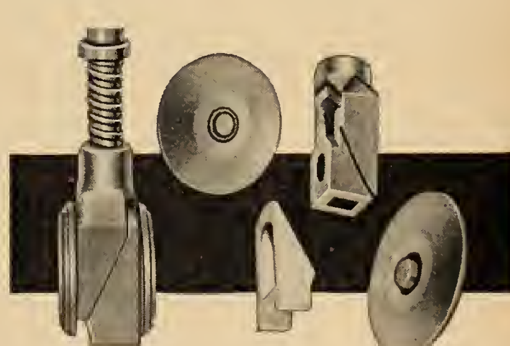


THIS VIEW of the disc assembly shows simplicity of design that makes it completely dependable in action. Entire assembly is suspended freely in valve body from stem, which engages upper spreader. Discs are suspended from upper spreader by trunnion principle.

1-5672

CRANE VALVES • FITTINGS • PIPING
PLUMBING • HEATING

NATION-WIDE SERVICE THROUGH BRANCHES, WHOLESALERS and PLUMBING AND HEATING CONTRACTORS good style, attractive presentation, and correct citation of sources used. There is also information on the typing and reproducing of a report. As the author points out, many companies have their own style manual, but in the absence of one of these, this report is an excellent guide. K. A. Kobe. New York, Interscience, 1957. 175p., $3.00.

*THE ECONOMICS OF SOVIET STEEL

A four-part study, based almost entirely on Soviet sources, of the development of the Russian iron and steel industry from 1917 to the present. The four parts are concerned, respectively, with the growth of production and investment; the specialization and size of plants and equipment; factors affecting plant location; and productivity. A considerable amount of statistical data is provided in appendixes, and a bibliography is included. M. Gardner Clark. Toronto, Saunders, 1956. 400p., $9.00.

ELECTRICAL ENGINEERING CIRCUITS

This basic text, for use in undergraduate study, presents the a-c circuit, and its underlying concepts in lucid form. Two thirds of the book is devoted to fundamental theory, while the rest introduces more recent material to prepare the student for advanced courses. The newer topics covered are: network theorems; loop and node equations of networks; locus curves and other graphical methods; resonance of high - Q circuits; impedence and admittance functions; poles and zeros in the complex frequency plane; the transform concept; and the Laplace transformation. A knowledge of basic physics and calculus is presumed, but complex algebra is presented in chapter 3.

This book has been used in preliminary form in the classroom by the author, and revised as occasion demanded. Summaries and problems are presented at the end of each chapter, and answers to every fourth question as well as a short bibliography are included. H. H. Skilling. New York, Wiley, 1957. 724p. $8.75.

ENERGY

Newly edited and illustrated, this book, first printed in 1929, and written by the well known English physicist, presents the basic concepts of energy. It may be understood by the layman, and also serves as a basic review for the expert. Perhaps its greatest interest for the latter lies in the form of presentation, which demonstrates how the subject may be interestingly presented and taught, as well as related to daily experience. Oliver Lodge. New York, Rider, 1957. 54p. $1.25 (U.S.).

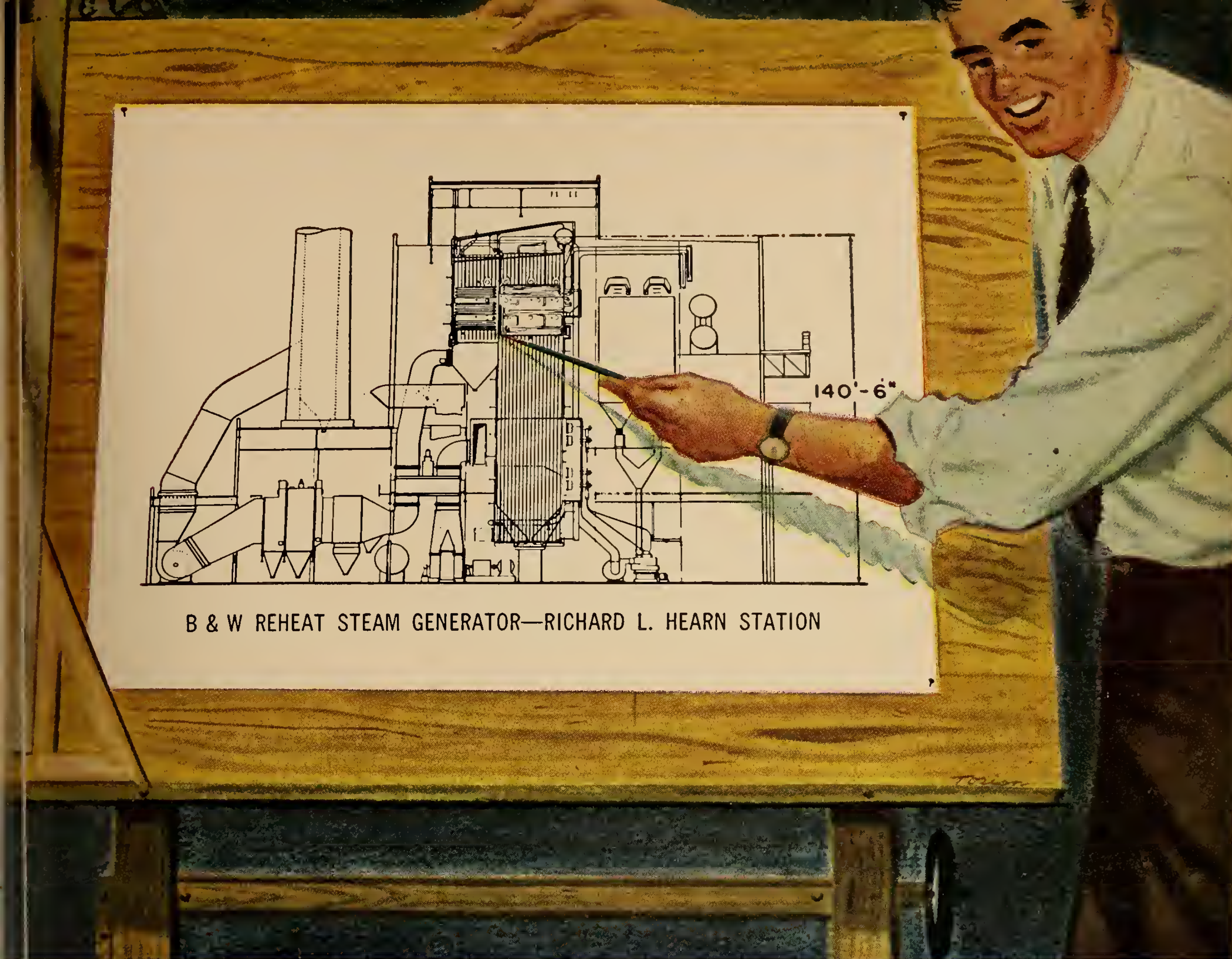
ENGINEERING AND TECHNICAL HANDBOOK

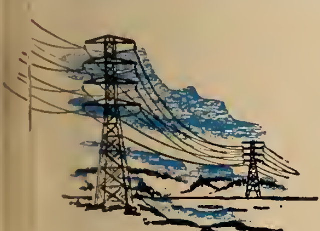
This compact handbook contains information in quick-reference, tabular form on the basic principles and formulas of engineering, technology, and the practical applications of the physical sciences. The five sections cover: basic fundamentals and formulas of general application; properties of materials, containing such information as: physical properties of water at various temperatures, beam diagrams, National Electric Code current carrying capacities, coefficients of friction, kinematic viscosity of various fluids, and numerous other subjects; equivalents and conversions; basic principles of mathematical operations from arithmetic to calculus, and finally, section five, containing twenty mathematical tables generally used in engineering and other technical fields. A. L. Hoag and D. G. NcNeese. Englewood Cliffs, N.J., Prentice-Hall, 1957. 376p., $6.00 (U.S.).

ENGINEERING THERMODYNAMICS

Based on the earlier text entitled Heat Power Engineering, by Barnard and Ellenwood, this book has been completely revised and brought up to date by C. O. Mackey.

The first six chapters include the basic principles of thermodynamics covering historical development; temperature, energy and first law of thermodynamics; processes and energy equations; second





TWO B&W REHEAT STEAM GENERATORS
for
ONTARIO HYDRO'S
RICHARD L. HEARN GENERATING STATION

The existing four boilers in the Richard L. Hearn Station are B & W units, each generating 850,000 lbs of steam per hour. These are, at present, the largest steam generating units in Canada.

To meet growing power demands, a major increase in output, pressure and temperature, including reheat, has been decided on for the extension of this station, and the Commission, through their Consulting Engineers, Stone & Webster Canada Limited, have placed contracts for two new boiler units with B & W. Each will deliver 1,350,000 lbs of steam per hour, at 1900 psig at the superheater outlet, with design pressure of 2200 psig, a superheated steam temperature of 1000° F, and a reheat steam temperature of 1000° F.

Thus, in 1958 Ontario Hydro will have in service a 200,000 kw steam turbo-generator powered by a *Reheat Steam Generator*—the first in Canada.

This will also be Canada's largest steam generating unit, with the steam drum more than 140 feet above the foundation floor. The second of the new B & W units will be similar.

BABCOCK **STEAM FOR PROCESS • STEAM FOR POWER** B&W STEAM

Member: Canadian Boiler Society

BABCOCK-WILCOX AND GOLDIE-McCULLOCH LIMITED, GALT, ONTARIO MONTREAL • TORONTO • CALGARY • VANCOUVER law of thermodynamics, temperature and entropy; general equations; and gases; properties and processes. The following chapters include: one-dimensional flow, properties of mixtures, and reactions of ideal gases; compression of air and other gases; engine cycles-gas; vapors; energy transformation in turbines; refrigeration and air-conditioning. The examples of the practical applications of thermodynamics are given to interest the engineering student by relating principles to practice. Problems and references are given at the end of each chapter. C. O. Mackey, W. N. Barnard and F. O. Ellenwood. New York, Wiley, 1957. 428p., $7.95.

THE FIRST ONE HUNDRED AND FIFTY YEARS

This history of the publishers John Wiley & Sons is more than a review of the titles they have published since 1807, it is also a history of the expansion of science and technology in that time, for Wiley is renowned as a publisher of technical books.

The first three chapters give a brief glimpse of New York as it was in 1807 when Charles Wiley opened his printing shop and bookstore, and the early history of the firm. The remaining chapters discuss, subject by subject, the books which have appeared over the Wiley imprint, showing how they have fitted into the contemporary scene. Nearly all the chapters have been written by Wiley authors, and the company is to be congratulated on the publication of this most interesting book which is also very well produced. New York, Wiley, 1957. 242p., $7.50.

FRICTION AND LUBRICATION

Based on experiments carried out at Cambridge University by the authors and their colleagues, this book gives an account of recent work and views on the mechanism of friction and lubrication.

The first five chapters discuss the various types of friction, and their causes, the part played by oxides and other surface films, and methods of measuring local temperatures caused by friction. Friction in non-metals is covered in chapter six, while the remainder of the book deals with the behaviour of lubricated surfaces.

There is a brief bibliography at the end of each chapter. F. P. Bowden and D. Tabor. Toronto, Ryerson, 1956. 150p., $2.25.

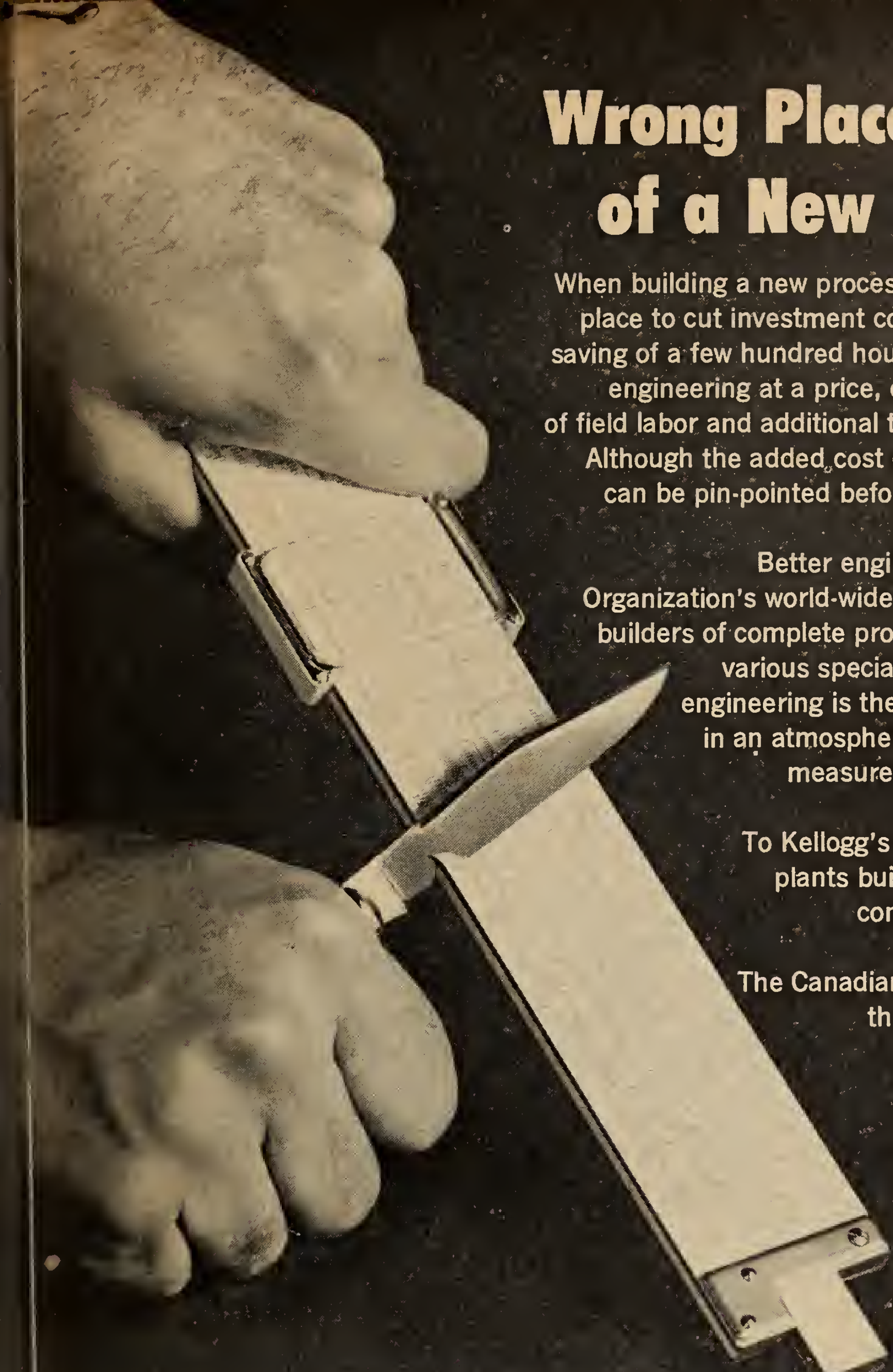
THE FUNDAMENTALS OF ELECTRIC LOG INTERPRETATION, 2D ED.

Electric logs are used to measure two quantities, the first of which is the variation in the borehole of electric currents flowing between shale beds and permeable beds whenever these are in contact. The second quantity is the electrical resistivity of the formations penetrated by the borehole. The book is in two parts, covering the theory and the practice of quantitative log interpretation.

In this second edition various corrections have been made, and the number of graphs greatly increased, a new chapter included on the treatment of abnormal spontaneous potentials, and new sections added on gamma-ray logging, the use of the neutron-gamma log to detect gas zones and determine porosity, and the acoustic velocity log. The section on gamma-gamma density logging has been expanded, and two final sections added on a general method of log interpretation and log quality control. M. R. J. Wyllie. New York, Academic Press, 1957. 176p., $4.50.

GRAPHICS FOR ENGINEERS

A book on engineering drawing which covers the fundamentals, but in which the emphasis is on engineering geometry, multiview representation, basic descriptive geometry, and freehand sketching, with particular attention to perspective pictorials and graphical methods for solving engineering problems. The purpose is to develop the ability to



Wrong Place to Cut Costs of a New Process Plant

When building a new process plant, engineering is the easiest place to cut investment costs. But it's the wrong place! The saving of a few hundred hours of engineering, or trying to buy engineering at a price, can cost thousands of extra hours of field labor and additional thousands of dollars for materials. Although the added cost of inadequate engineering seldom can be pin-pointed beforehand, it is inevitably reflected in the operating record of the plant.

Better engineering is the basis of the Kellogg Organization's world-wide reputation both as engineers and builders of complete process plants and as consultants on various special engineering projects. This better engineering is the result of good engineers working in an atmosphere where sound engineering is the measure of success for both the individual and the organization.

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visualize spatial conditions and to use graphical forms of representation as a means of communication. There is a special chapter on graphs, charts, and nomograms. W. J. Luzadder. Englewood Cliffs, N. J., Prentice Hall, 1957. 579p., $8.65.

THE HISTORY OF ELECTRIC WIRING

Any electrical installation can be only as good as its wiring, so that its history is an important part of the history of electrical engineering.

The author, a practising engineeer, has had the co-operation of many firms, organizations and individuals in writing this history which covers the period from 1870 to the present. The first six chapters provide a chronological review, presenting contemporary ideas, the histories of some of the firms in the trade, the effect of legislation, and the exchange of ideas with other countries. One chapter is devoted to Lord Kelvin's contributions to installation practice. The history of the various components is given, including cables, conduits, branch switches, lampholders, plugs and sockets, fuses, and bus-bar trunking and duct systems. One chapter is devoted to the prefabrication of wiring systems, and one to recent developments such as installation in ducts in concrete. John Mellanby. London, Macdonald, 1957. 244p., 32/6.

AN INTRODUCTION TO SEMICONDUCTORS

W. C. Dunlap is eminently qualified to write the first book on semiconductors to completely cover the field. His many years as consultant on semiconductors have enabled him to present his subject simply and without a mass of complex mathematical theory and the space thus saved has been devoted to directly usable information. Therefore having read the book, you are prepared for active work in the field.

Well illustrated with diagrams and graphs, this subject is approached on an almost entirely physical level. The topics covered range from crystals and the solid state theory through statistical mechanics for metals and semiconductors; electron theory of metals and semiconductors; properties of p-n junctions to rectifiers: transistors; photocells, thermistors, hall effect, and other semiconductor applications. It also covers contract and surface properties, experimental measurements, general methods of preparing materials, semiconducting compounds and the properties of the elemental semiconductors.

It is lucidly written, well indexed with extensive references at the end of each chapter. W. C. Dunlap, Jr. New York, Wiley, 1957. 417p., $11.75.

INVENTORS AND INVENTIONS

The story of the development of modern technology is to a large extent that of new inventions. In this publication, the author, who is director of patent operations at R.C.A. Laboratories at Princeton, N.J. examines the psychology and methods of invention. Notable examples of the works of famous inventors are given, whose discoveries have been arrived at through various means ranging from painstaking scientific experiment and discovery to happy accident. The conception of the invention is examined and related to the environment, education and age of the men who have created the things that are now part of our civilization. Finally, the nature of patentable inventions and a non-legalistic explanation of protecting and patenting is given, as well as pointers on marketing inventions. The book is well documented giving relevant graphs and tables concerning the subjects under discussion. References are included at the end of each chapter. C. D. Tuska. Toronto, McGraw-Hill, 1957. 174p., $4.50.

MATHEMATICS AND COMPUTERS

This book, written for the non-specialist, is intended to present the relationship between pure and applied mathematics, and the new role of automatic computers in helping to solve the problems of science, engineering and business. It deals with the field of applied mathematics, with special emphasis placed on the commuting methods and devices used by the mathematician, and the uses and workings of automa-

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and the uses and workings of automatic digital computers.

Topics presented are: numerical analysis; digital computer components; logical design of digital computers, analog computers and simulators; computing with random numbers; computer errors; and computers at work. Suggestions for further reading are given at the end of each chapter, and a selected bibliography is included. G. R. Stibitz and J. A. Larrivee. Toronto, McGraw-Hill, 1957. 228p., $6.00.

MODERN CHEMISTRY FOR THE ENGINEER AND SCIENTIST

This collection of nineteen papers by outstanding chemists, each an expert in his respective field, was first presented as an extension course at the University of California to acquaint scientists and engineers, who had been practising for some years, with the newer developments and fields of investigation in modern chemistry. The papers are at quite an advanced level, and deal with subjects that should profoundly affect modern technology in the near future. The subjects covered are: chemical thermodynamics; contact catalysis; photochemistry; chemical kinetics; isotopic tracers; column chromatography; organic reaction mechanisms; rubber elasticity; carbon - fluorine compounds; silicones; petrochemical industry; chemical relations in earth; creep of metals as reaction-rate phenomenon; crystal chemistry and pyrochemistry of clay materials; food technology; biochemistry of insecticides; chemical constitution and physiological action; chemical synthesis in living organisms; and the configuration of polypeptide chains in proteins. References are included with each paper. G. R. Robertson, ed. Toronto, McGraw-Hill, 1957, 442p., $11.40.

*NATIONAL STANDARDS IN A MODERN ECONOMY

Comprised of a series of articles by well-known authorities, this book is an examination and assessment of the standards movement as a whole within the United States. The articles deal with the history of the movement and with applications of standards in specific fields: interchangeable parts manufacture, supply and purchasing, telecommunications, agricultural products, military goods, consumer goods, etc. A review of the international standards movement is included, and a number of articles are devoted to the implications of standardization for management, labor and the consumer. Dickson Reck, ed. Toronto, Musson, 1956. 372p., $6.00.

PIN POINT T.V. TROUBLES IN 10 MINUTES

Intended as a guuide for T.V. servicemen, this publication is concerned with trouble location and correction rather than theory. Check charts and cross references are given for the location of the most probable causes of picture faults. Methods for checking the performance of various receiver parts and components, as well as precautions in making tests and replacements are given. The circuits and designs of the majority of television receivers produced since 1953 are explained and covered in the tables of faults. Chicago, Coyne Electrical School, Indianapolis, Sams, 1957. 299p., $3.95 (U.S.).

PRACTICAL APPLICATIONS OF ENGINEERING SOIL MAPS

During the last nine years, under the sponsorship of Rutgers University and the New Jersey State Highway Department, twenty-one reports on the soil conditions existing in the state have been published. This twenty-second and final report contains information of general interest, as well as a summary of the materials available in New Jersey, particularly those of interest to the highway engineer.

The soil mapping techniques used in the survey are explained, and the symbolic notations employed, and there is a chapter on the practical uses of engineering soil maps and reports.

Anyone considering making a soil survey would be well advised to read this and the first report in the series which dealt with soil environment and methods of research. W. W. Holman and others. New Brunswick, N.J., Rutgers University Press, 1957. 114p., $3.00.

• LIBRARY NOTES

PRINCIPLES OF ENGINEERING GEOLOGY AND GEOTECHNICS

Geotechnics, the application of the earth sciences to the solution of civil engineering problems, forms the subjects of this book written by a foundation engineer and a geologist.

The first eight chapters contain general geotechnical information on engineering properties of rocks and soils, soil mechanics, subsurface water, subsurface exploration, maps and airphotos, and rock as a construction material. Following chapters show the use of this information in the design of buildings, bridges, dams, tunnels, runways, highways and shore structures. There are also chapters on aseismic design, landslides and the legal side of geotechnics.

Of particular interest is the information given relating to frost and permafrost and its effect on construction. There are numerous illustrations throughout this well-presented text, and references are given at the end of each chapter. D. P. Krynine and W. R. Judd. Toronto, McGraw-Hill, 1957. 730p., $12.00

PRINCIPLES OF ENGINEERING HEAT TRANSFER

In this basic text the author describes the principles and concepts of the role of heat transfer in engineering, covering energy transfer, fluid flow, conduction, convection and radiation.

The overall picture of energy transfer is presented first, and the part played by conduction, convection and radiation illustrated. Special attention is paid to the important topic of convection, and the chapters on fluid flow serve as an introduction to this.

A knowledge of physics, mathematics and thermodynamics is assumed, and the book is designed for electrical and industrial as well as mechanical engineering students. W. H. Giedt. Toronto, Van Nostrand, 1957. 372p., $10.00

PROCEEDINGS OF THE SECOND RETMA CONFERENCE ON RELIABLE ELETRICAL CONNECTIONS

This second conference sponsored by the Radio-Electronics-Television Manufacturers Association was held in 1956, and the thirteen papers presented covered soldered, solderless and brazed connections; ultra-sonic joining; equipment and tools; fluxes; surface qualities; soldering to printed wiring boards, etc.

The conference serves to emphasize the importance of reliable electrical connections in the modern world with its reliance on electrical and electronic equipment. New York, Engineering Publishers, 1957. 103p., $5.00 (U.S.).

PROPERTIES OF PETROLEUM RESERVOIR FLUIDS

Although petroleum engineering practice is constantly changing, certain fundamental concepts remain unchanged, and it is the aim of this text to describe those basic concepts connected with reservoir fluids. The properties of ideal fluids are described, as well as empirical correlations necessary in dealing with the complex mixtures generally existing in petroleum reservoirs.

The topics covered include the properties of the hydrocarbons which constitute petroleum, and their behaviour in a gaseous state, the phase behaviour of liquids and the qualitative phase behaviour of hydrocarbon systems, quantitative phase behaviour, reservoir fluid characteristics and the applications of those characteristics.

The principles discussed are illustrated with many worked examples, and many tables and charts needed to solve problems often found in this phase of petroleum engineering are included. The author has also included references for further reading, and problems the working of which will further illustrate the basic concepts presented. E. J. Burcik. New York, Wiley, 1957. 190p., $7.50

THE RADIO AMATEUR'S HANDBOOK, 34th ED.

A standard manual and reference work for radio amateurs and experimenters, this edition includes information on new equipment including v.h.f. high-powered amplifiers, beam antennas, semi-conductors, and new tables on vacuum tubes. Basic theory is included throughout, and the receiver and the transmitter sections give simple as well as more complex unit construction data. Other sections include: high-frequency receivers and transmitters, speech amplifiers and modulators, single side band, transmission lines, and assembling and operating a station. American Radio Relay League. West Hartford, Conn., The League, 1957. 750p., $4.00.

REALITIES OF SPACE TRAVEL

As space travel comes ever closer to being an accomplished fact, astronautical experts are slowly solving the problems that lie in the way of interplanetary flight. The whole field is surveyed in this book, which contains twenty-four papers presented before the British Interplanetary Society. The topics covered include: requirements for leaving the earth's atmosphere and combating gravity; the artificial satellite; limitations of chemical propellents and the introduction and development of the atom rocket; the history and development of rockets; physical and biological aspects of space travel, the dangers of meteors and cosmic rays; probable first targets, the Moon and Mars with an analysis of their physical conditions; establishments and testing stations; and probable future developments. Selected references are included with each paper. L. J. Carter, ed. London, Putnam, 1957. 431p., 35/-.

REPAIRING TELEVISION RECEIVERS

This publication is a manual for those with a basic knowledge of TV theory and test instruments. Repair procedures are emphasized by explaining how to localize defective sections, then the defective stage, and finally the defective component. The first six chapters cover servicing techniques including a key check system for determining trouble. Succeeding chapters explain how to apply these techniques to various servicing situations. A supplementary checklist of causes of trouble is given, indicating circuit components which usually cause particular failures. C. Glickstein. New York, Rider, 1957. 206p., $4.40 (U.S.)

RESONANT CIRCUITS

The theoretical basis of the resonant circuit is treated in this publication, starting with basic theory related to resonance, and continuing with discussions of various arrangements of the resistor, capacitor and inductor in forming circuits. The series, parallel, and series-parallel combinations are discussed and analyzed. Resonant circuits with distributed constants, resonant coupled circuits and circuit applications are included. This is volume 16 of the Rider's Electric Technology Series. A Schure, ed. New York, Rider, 1957. 66p., $1.25 (U.S.)

ROLL-ON, ROLL-OFF SEA TRANSPORTATION

These are the proceedings of a symposium held in November 1956 under the auspices of the Maritime Cargo Transportation Conference. The subject under discussion is the principles and advantages of the "trailership' on which a cargo is loaded and taken off by means of trailer vans or rail cars. The six papers presented cover various aspects of the subject, such as trailership operations, shoreside facilities, and design of trailerships. Washington, Nat'l Academy of Sciences, Nat'l Research Council, 1957. 49p. $1.25 (U.S.).

WATER FOR INDUSTRY

In order to publicize the necessity for continued hydrological investigation and control, this symposium was sponsored by several scientific societies. The control problem under study was that of natural water resources; supply and industrial requirements for the present and future. It is pointed out that without the application of adequate conservation methods, water supply will be a widespread problem, as it is now, in some areas. Subjects covered in the nine papers presented are: the available water supply and water requirements; the treatment and disposal of wastes in the atomic energy industry; water supply and waste disposal requirements for industry; anti-pollution legislation; water in the future. J. B. Graham and M. F. Burrill, eds. Washington, American Association for the Advancement of Science, 1956. 141p., $3.75 (U.S.)

LIBRARY NOTES

°WOOD STRUCTURAL DESIGN DATA, VOLUME 1, 3rd. ED.

This new edition includes significant developments in the field which have occurred since the publication of the second edition in 1939. Among these are the timber connector system of wood construction, structural glued-laminated lumber, simplified methods of column design, and more specific information on the relation of load duration to allowable stresses. Since this is intended as a practical reference aid for wood structural design, the data are presented for the most part in tabular form. There is a subject bibliography at the end. Washington, National Lumber Manufacturers Association, 1957. 362p., Spiral Binding, $4.00 (U.S.).

TECHNICAL BULLETINS AND PAMPHLETS RECEIVED

Electrical Engineering

The Electrical Research Association. Technical Reports:—C/T118—The combination of local energy resources to provide power supplies in under-developed areas. E. W. Golding F/T188—Current carrying capacity of small cables for domestic and small commercial installations. R. G. Parr F/T191-Current ratings and impedance at 50 c/s and at 400 c/s of 3-core paper insulated lead covered single-wire armoured cables and single-core vulcanized rubber insulated cables in steel conduit. R. G. Parr G/T307—A four-channel cathode-ray oscillograph with automatic brilliance control. M. T. Cree L/T329—Electrical and optical characteristics of D. C. corona discharges in air at atmospheric pressure. B. Murphy. T/T54—Nomographic representation of elastic contact conditions between steel pivots and sapphite or diamond jewels. G. F. Tagg.

Survey of electric utility system planning practices. (Edison Electric Inst. Pub. 57-4).

Symposium on corona. (A.S.T.M. s.t.p. 198).

Highway Engineering

Highway administration

Secondary road program in North Carolina. (U.S. Highway Research Board. Bibliog. 19 and Bull. 147.)

Techniques of road construction over organic terrain. I. C. MacFarlane. (Canada. N.R.C. Div. of Bldg. Research. Tech. Paper no. 45).

Snow

A field determination of free water content in wet snow. G. P. Willams.

The strength of snow in compression. L. W. Gold. (Canada. N.R.C. Div. of Bldg. Research. Res. Papers nos. 26 and 29).

Soil Mechanics

Annotated tables of strength and elastic properties of rocks. R. G. Wuerker. (Illinois. Univ. dept. of mining and metallurgical engineering.)

Muskeg access, with special reference to problems of the petroleum industry. N. W. Radforth. Tech memo No. 43.

Proceedings of the eastern muskeg research meeting, Feb. 22, 1956. Tech. memo. No. 42.

Proceedings of the ninth Canadian soil mechanics conference, Dec., 1955. Tech. memo. No. 41.

(All: Canada. N.R.C. Associate committee on soil and snow mechanics.) Factors influencing ground freezing (U.S. Highway Research Board, Bul. 135.)

Soldering

Symposium on solder. (A.S.T.M. s.t.p. 189).

Structural Engineering

British construction equipment 1957. (The Federation of Manufacturers of Contractors' Plant).

Photogrammetric measurements of deformations of structures. C. Moser and W. R. Schriever. (Canada. N.R.C. Div. of Bldg. Research. Paper no. 30).

Steel sheet piling. (Union Sidèrurgique Lorraine, Europam Corp.).

Study of columns with perforated cover plates. M. W. White and B. Thurlimann. (Column Research Council).

Traffic Engineering

Accident analysis and Impact Studies

Night visibility 1956 (U.S. Highway Research Board. Bulletins nos. 142 and 146).

Noise control in Toronto's new subway. W. H. Paterson and T. D. Northwood. (Canada. N.R.C. Div. of Bldg. Research. Paper no. 28).

Weights and Measures

Reports of the 41st national conference on weights and measures, 1956. (U.S. Dept. of Commerce. Nat'l Bureau of Stds. Misc. Pub. 219).

Annual Reports

Canada. Civil Service Commission. 1956.

Canada. National Harbour Board. 1956.

Nova Scotia Technical College. 1956.

Miscellaneous

Annotated bibliography on hydrology 1951-54 and sedimentation 1950-54 (U.S.

and Canada) (U.S. Nat'l. academy of Sciences.)

Aviation directory of Canada. 1957 (Aircraft.)

Control, stability and choice. G. Vickers. Toronto. University, 9th Wallberg lecture.)

Cyclone atomizer for briquet binder. J. Visman. (Canada. Dept. of Mines. Tech. Paper no. 17.)

A design for laboratory furniture. E. H. Stock and J. S. Keeler. (Canada. N.R.C. Div. of Bldg. Research Tech. Paper no. 44.)

La physique moderne et son interpretation. P. Chambadal. Paris, Colin, 1956.

Policy declarations and resolutions 1956-57. (The Canadian Chamber of Commerce.)

Private and public investment in Canada. Outlook 1957. Regional estimates, Supp. (Canada. Dept. of Trade and Commerce).

Symposium on steam quality. (A.S.T.M. s.t.p. 192.)

STANDARDS RECEIVED

A.S.T.M. Standards, American Society for Testing Materials, 1916 Race St., Philadelphia 3.

1956 supplements to books of A.S.T.M. standards including tentatives. Part 1: Ferrous metals. 447p., Part 3: Cement, concrete, ceramics, thermal insulation, road materials, waterproofing, soils. 325 p., Part 4: Paint, naval stores, cellulose, wax polishes, wood, acoustical materials, sandwich and building constructions, fire tests. 215p., Part 5: Fuels, petroleum, aromatic hydrocarbons, engine antifreezes. 310p., Part 6: Plastics, electrical insulation, rubber, electronics materials. 354p.

British Standards, British Standards Institution, 2 Park St., London, W.1. Also available from the Canadian Standards Association.

B.S. 24:1956. Railway rolling stock material: Part 2: Tyres. 3/6. Part 6: Steel slabs, plates sections bars and rivets. 5/-.

B.S. 215:1956. Aluminium conductors: Part 1: Aluminium conductors for overhead power transmission purposes. 3/6. Part 2: Steel-cored aluminium conductors for overhead power transmission purposes. 3/6.

B.S. 698:1956. Papers for electrical purposes. 7/6.

B.S. 1347:1956. Architects', engineers' and surveyors' boxwood scales. 5/-.

B.S. 2772:1957. Iron and steel for colliery haulage and winding equipment: Part 3: 1.5 per cent manganese steel castings for mine car couplers. 3/-.

B.S. 2790:1956. Cylindrical land and steam boilers of welded construction (other than water-tube boilers) 12/6.

B.S. 2806:1956. Limiting dimensions of air filters for internal combustion engines and compressors other than aircraft. 3/6.

B.S. 2G.115. Sensitive altimeters for aircraft. 3/6.

Canadian Standards. Canadian Standards Association, National Research Building, Ottawa.

B139-1957 Installation code for oil burning equipment. $2.00.

Canadian Electrical Code: Part 1

C22.1-1953 Interim revisions. 40 cents.

Canadian Electrical Code: Part 2

C22.2 No. 2-1956 Construction and test of electric signs. 3d ed. $1.25.

C22.2 No. 44-1957 Construction and test of flexible non-metallic tubing. 2nd ed. 50 cents.

C22.2 No. 48-1957 Construction and test of non-metallic sheathed cable. 3d ed. $1.75.

C22.2 No. 51-1957 Construction and test of armoured cables. 5th ed. $1.25.

C22.2 No. 65-1956 Construction and test of wire connectors. $1.00.

C22.2 No. 66-1956 Construction and test of specialty transformers. 2d ed. $1.75.

C22.2 No. 75-1957 Construction and test of thermoplastic-insulated wires and cables. 4th ed. $1.25.

C22.2 No. 77-1957 Inherent overheating protective devices for motors. 2nd ed. 50 cents.

C22.2 No. 78-1956 Construction and test of varnished-cloth-insulated wires and cables. 2d ed. $1.75.

C22.2 No. 109-1957 Construction and test of commercial cooking appliances. $2.00.

C22.2 No. 111-1956 Construction and test of manually-operated general-purpose A-C switches. $1.00.

C127-1957 Specification for fibre conduit. $1.00.

C138-1956 Specification for single-phase pivot-type transformers type one for rural applications. $1.00.

0121-1957 Specification for Douglas fir plywood and western softwood construction plywood. 50 cents.

Z142-1957 Code for the guarding of punch presses at point of operation. $1.25.

Z143-1956 Specification for common names for pest control chemicals. 75 cents.

ENGINEERING CAREERS

Municipal Engineering

MUNICIPAL engineers, in the general sense, are responsible for the development of the communities in which we live and for the operation and expansion of the facilities associated with a modern community.

The operations involved may range from those of a large public works department required to run a city of over a million inhabitants to the single municipal engineer who may administer the public works requirements of a small mining town in a remote area.

The importance of the field in Canada may be judged by the fact that the total expenditure on construction and public works in 1956 by municipal authorities was estimated to be of the order of $300 million, a figure comparable with the corresponding expenditure by the Federal government; the ten provinces spent some $500 million in the same field during the year. Undoubtedly the volume of municipal work will continue to grow considerably—as one example, about 55 per cent of the Canadian population is served by some 845 municipal sewerage systems, whereas there are nearly 1600 municipal waterworks systems serving about 65 per cent of the population. Obviously there is much work to be done to make more adequate provision of these facilities for a growing populace.

Seen during its construction is the new civic auditorium at Calgary. A duplicate auditorium was also built at Edmonton during 1956. Some 1300 tons of steelwork were used in each.

Fields of Engineering

The field of municipal engineering is very wide, and there is a great demand for civil, mechanical, and electrical engineers to keep up with the current rapid growth of the country's communities in general, and of the larger urban centres—the cities—in particular.

A modern urban community demands good roads, lighting, water supply, sewage disposal, hospitals, schools, and other facilities that may be the responsibility of the municipal authorities. These facilities must be planned, installed, maintained, and expanded as the community grows.

Town Planning

Before discussing these municipal engineering operations in greater detail, mention should be made of the important field of town planning, on which the future of the community depends so greatly.

In the words of the director of city planning of a Canadian city that has a population of well over a million people:

"City planning is concerned mainly with providing a decent environment for living. There is no doubt that the art of the engineer has a great contribution to make towards the efficient physical growth and good arrangement of communities in harmony with their social and economic needs. No master plan would be efficient without the engineer's intervention in the fields of circulation systems, such as railroads, rapid transit, bus lines, main highways and local streets and pedestrian ways; of buildings, public and private; of open spaces, such as parks, playgrounds, reservations, waterfronts, and airfields; and of public utilities, including water and sewer mains, sources of supply and places of disposal; gas, electricity, and telephone. The engineer with his sense of scientific knowledge and analysis of facts, is one of the technicians most vitally needed for planning adequately the physical layout of our communities."

Public Works

In the larger cities the municipal engineering operations are usually the concern of a department of public works. Details may vary from city to city, but in general this department is equipped to provide the facilities mentioned above.

A typical department will have a director, or other chief executive, who is often himself an engineer, together with an administrative staff, also with a large proportion of engineers in the senior positions. The main divisions of the department will probably deal with: planning and new developments; construction; and operation and maintenance. New works and the operation and maintenance of existing facilities are usually handled by separate divisions.

Planning — Many civil engineers are required for surveying work and for the preparation of plans, which may be used in the future development of the community. Plans are also required for use in the legal courts in such cases as the expropriation of land by a city and the establishment of property rights. Surveys are carried out for traffic routes, sewers, and so on, and plans and specifications drawn up for such installations as waterworks. To meet the needs of future expansion, long-term planning is carried out by appropriate groups of engineers.

Water and Sewage — The design and construction of water supply and sewage disposal systems calls for engineers with a knowledge of hydraulics for some phases of the operations.

Traffic Routes — Engineers are concerned with the design and construction of roads, bridges, subways, and other routes.

An example of a modern school belonging to a municipality is the 57,000 sq. ft. area regional high school at Liverpool, N.S., of which the entrance to the auditorium is shown here.

Buildings — A public works department may have its own staff of architects to design new buildings such as administrative offices, hospitals, schools, and buildings for public utilities. With this division, a group of mechanical and electrical engineers is required for the design and installation of heating, air conditioning, lighting, and so on.

Electrical — Electrical engineers are responsible for the installation of equipment such as street lighting, traffic signals, and fire alarm signals. A further important field is that of electrical power distribution and such installations as electric motors for water pumping, transformers, and so on.

Local Improvements — When opening a new area of a community, a group of engineers will supervise the provision of new streets and main services for the locality.

Parks — Many large cities and towns have a department responsible for the development and maintenance of parks and other open spaces and recreational facilities. Here, again, engineers are concerned with the surveying of sites, grading of land, drainage, and installation of lighting and other equipment.

Maintenance — The buildings, roads and bridges, and other facilities already mentioned must be maintained in good condition, and to this end a public works department will employ groups of workers under the supervision of engineers experienced in the different fields.

Opportunities for the Engineer

A large public works department will generally accept the newly-graduated engineer for employment (particularly in the fields of civil, electrical, and mechanical engineering, as mentioned above) and, after determining the field to which he is best suited by inclination and training, will place him in the appropriate division to work with a senior engineer in order to get experience on the actual job.

From an engineer in training, advancement is generally in regular steps, according to the salary scale applicable to the particular department, for the first year or so and up to a certain level of experience. Above this the engineer who is suitably qualified may advance to supervisory positions in charge of engineering groups and finally of operations in an administrative district of the city or other area of operations.

As mentioned above, the senior executive positions are also frequently filled by engineers who have advanced in this field.

Consulting Engineers

In many cases the volume of work involved in planned community projects may be beyond the potential of even a large public works department, and in such cases use is made of the services of consulting engineers to carry out certain of the projects. In the case of smaller communities, in which there may be only a single engineer to administer local works, the services of consulting engineers are also widely used.

Salary and Benefits

In the field of municipal engineering, salaries are not always comparable with those that can be obtained in industry, but in general there are other advantages such as shorter working hours and considerable social security. Normal paid vacations apply and pension plans, health and life insurance schemes and similar benefits are available at favourable rates.

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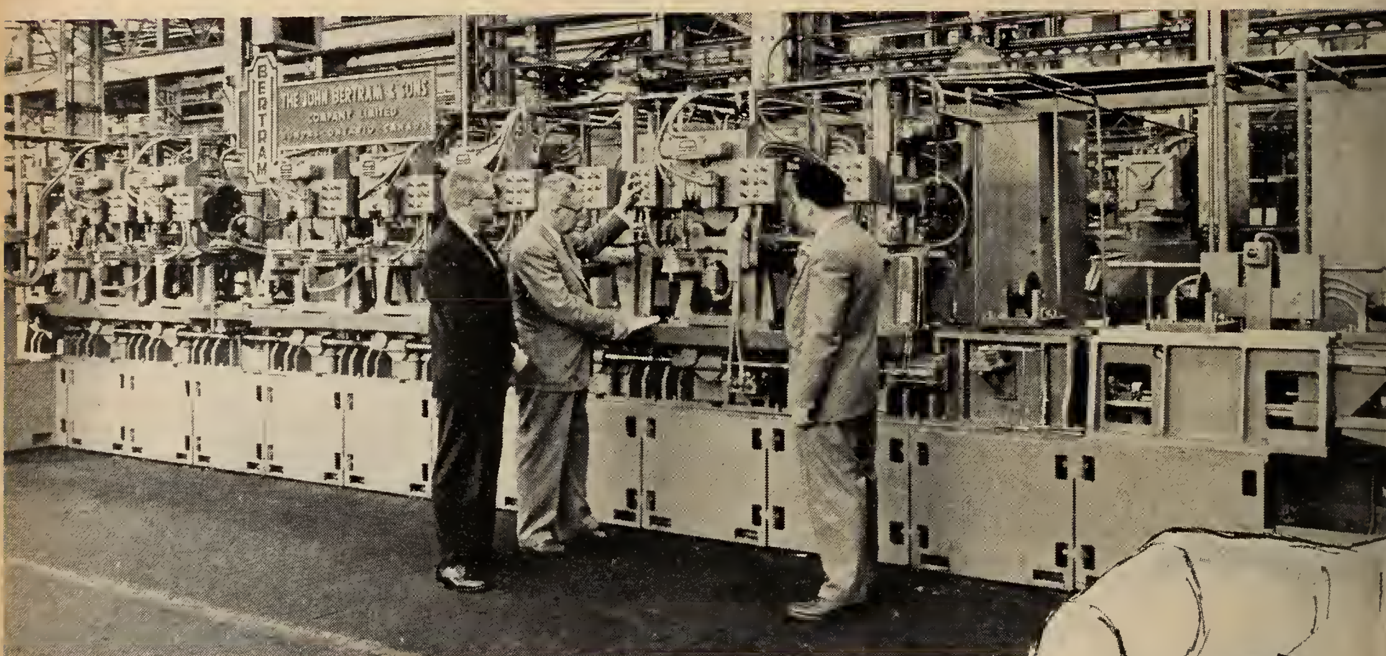
LATEST REPORT ON AUTOMATION...

Westinghouse CYPAK at work!



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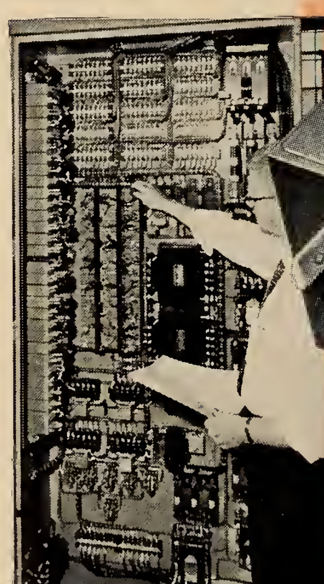

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Engineering the R.C.A.F. Argus

William K. Ebel, *Vice-president Engineering,*

and

E. B. Schaefer, *Assistant Chief Engineer,*

Canadair Limited, Montreal.

Read at the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June 1957.

To meet the particular requirements of the Royal Canadian Air Force for a maritime patrol aircraft, the Bristol Britannia has been adapted and considerably modified. This paper describes the work done by Canadian engineers to make this adaptation.

THE ARGUS, the largest aircraft which has been built in Canada to date, has rather an interesting design genealogy, and development background.

The Royal Canadian Air Force put forth a requirement for a maritime patrol aircraft that would replace the World War II Lancasters, and supplement the Neptunes which are now operated by the Maritime Command. This decision having been made the next step was to determine which aircraft would meet the requirement, when it would be available for service use, and whether or not the cost would be in line with the budget allowance. At this point the R.C.A.F. requested Canadair to prepare design studies and cost analysis on the basis of two approaches to the problem.

The first of these was to assume design, manufacture and development of an original aircraft that would meet the type specification, and the second was to adapt the Bristol Aeroplane Company's Britannia Mark 100 aircraft to meet the same specification. For a number of reasons the decision was taken to adapt the Britannia type, whereupon the Government of Canada concluded a license agreement with Bristol and appointed Canadair as its agent to procure the necessary engineering information from Bristol, adapt the Britannia basic design to the specific military requirement, tool, manufacture, and develop the maritime patrol aircraft.

The Canadair engineering division staff has been charged with the responsibility of preparing and releasing all drawings and data required to the Air Force specification. In addition complementary test programs on components and assemblies had to be determined, test rigs designed and erected, exacting tests run, results obtained and analyzed for proof of compliance with specification. All of this adds up to a major engineering effort, and this paper is presented on behalf of all those who have contributed to the solution of the engineering problem.

Grateful acknowledgement is made to the Royal Canadian Air Force for permission to present and publish the information contained herein.

The Engineering Problem

In broad terms the problem is one of converting a civil operation type passenger carrying aircraft to a military type capable of transporting a highly trained operational crew with all of the specialized equipment and strike armament on a specified military mission.

The primary role of a maritime reconnaissance aircraft is stated by the R.C.A.F. to be the protection of sea lanes of communication, including the detection and attack of enemy submarines. While security regulations will not permit statement of specific performance characteristics such as speeds, range, endurance etc. several obvious conclusions become apparent from the simple statement of role. In order to protect sea lanes of communication between the coast lines of Canada and those of friendly nations the patrolling aircraft must have long range capabilities. The detection of and attack on enemy submarines obviously require the ability to fly at low altitudes and at slow air speeds for long periods of time. Hence long endurance time in the air is necessary.

The general military requirements just mentioned then sum up to an overall mind picture as to the type of aircraft that will accomplish the objective. It must be large enough to house and power all of the involved detection equipment, carry the attack weapons, provide adequate and comfortable working space for the aircraft operating crew, the tactical crew to direct and carry out detection and attack, provide comfortable rest quarters for off duty personnel and allow for station interchange of crew members in flight. Long range and endurance at low altitudes and slow airspeeds demand large fuel tankage capacities and low fuel consumption engines.

The Britannia Mark 100 is a large aircraft with sufficient body volume to house the personnel and equipment, and wing fuel tankage necessary for the range and endurance. The Britannia power plant is of the turbo-propeller type which operates most efficiently at high speeds and high altitudes, and would therefore not be appropriate for the maritime reconnaissance aircraft flight mission at low altitudes and slow air speeds. The aircraft having been designed as a civil licensed passenger carrying vehicle will require substantial redesign and adaptation to suit the military role.

The next problem to be considered has to do with design and material standards. The R.C.A.F. have established the firm and reasonable policy that aircraft built in Canada shall conform to CAP 479 "Manual of Aircraft Design Requirements for the Royal Canadian Air Force" which manual sets forth detail design and material specifications. In particular, material standards called out are North American standards. Such a policy is obviously logical from a point of view of North American continent procurement and general logistics considerations. The Britannia, designed in the United Kingdom to British Ministry of Supply design requirements and materials standards does not therefore, in all cases, satisfy R.C.A.F. requirements. Thus, an Americanization program is indicated for the adaptation.

A third problem encountered has to do with the aircraft systems. Aircraft systems include such items as electric power supply and distribution, hydraulics, pneumatics, fuel, oil, radio and communication, heating and ventilating, cabin pressurization, de-icing and anti-icing, instrumentation, armament etc. Here again the Britannia aircraft systems have been designed to meet requirements that are at large variance with those for the maritime aircraft with the result that some of these such as the electrical system had to be completely redesigned while others were adapted and changed only where required. As has been mentioned previously, the turbo-propeller power plant of the Britannia was not suitable for the maritime operation, hence an entirely new power plant was designed around a reciprocating turbo-compound engine and fitted to the aircraft.

Fig. 1. Bristol Britannia Aircraft.

The general nature of the problems having been outlined it is now appropriate to discuss some of them in more detail and indicate the solutions and necessary compromises that have been attained.

The Engineering Solution

Airframe.—The airframe is defined as the wing, body, or fuselage, tail surfaces, landing gear, power plant and nacelles. On these items two separate, but still inter-related problems are encountered. These are Amer canization and redesign.

In the case of adaptation of Britan nia structural design all material stan dards and specifications are converte from those of the United Kingdo to those of North America. Whe redesign is called for the conversio process is of course unnecessary. Th broad guides for conversion of sta dards are:—

(1) The use of materials availab in North America.

(2) The use of standard parts an hardware available in North Americ

(3) The use of equipment iten available in North America.

All conversion items are not clear cut as indicated by the rul just given. For example, some pa and equipment designed for Britann could be built in Canada followi United Kingdom standards, and therefore would be wasteful of eng neering time and cost to complete redesign to other standards. Ho ever, in these cases any requir plumbing or wiring fittings necessa for connection to the aircraft pow systems are designed to Americ standards.

In illustration of the areas of m terial standards conversion and design required on the airfran sketches are shown wherein t white backgrounds indicate th areas requiring only conversion material standards and the doul cross hatch backgrounds indic

Fig. 2. Canadair R.C.A.F. Argus.

those areas requiring complete structural redesign. Since there are areas of the airframe which require something less than complete redesign these are indicated by the single cross hatch. The sketches illustrate that the wings and tail surfaces essentially are structurally unchanged in design except for the material standards conversion process. The United Kingdom and American material standards do not, unfortunately, always agree in terms of gauge, weight, metallurgical and physical characteristics so that substitution of materials is a matter of engineering analysis and experience. The prime rules governing choice are:—

(1) Equal or greater strength, within the bounds of weight control.

(2) Equal or greater fatigue resistant characteristics.

(3) Adaptability to Canadair's tooling and manufacturing processes.

The third governing rule was violated in one major respect, namely in the case of structural metal bonding. Metal bonding is the process whereby two or more pieces of metal are structurally fastened together by means of a resin type of adhesive which is set with heat and under pressure. A considerable portion of the Britannia secondary structure is fabricated by use of metal bonding, and conversion of such components to riveting or welding fabrication would entail a large weight penalty. Therefore, it was decided that although Canadair had no experience in the use of metal bonding, the process would be used on the maritime aircraft. As a result the engineering and manufacturing divisions of the Company collaborated in choosing the particular metal bonding process to be used, setting up design and test standards, equipping the shop with the necessary tools and developing the handling techniques required for a satisfactory product.

In contrast to the cases of the wings and tail surfaces it will be noted that the fuselage or body of the aircraft requires a considerable amount of actual redesign of the basic structure, and a complete redesign of interior arrangements and furnishings. In a practical sense the fuselage redesign amounts to about 95 per cent of that required for an original design.

The power plant entails 100 per cent new design forward of the nacelle firewall due to the use of a piston engine and accessories instead

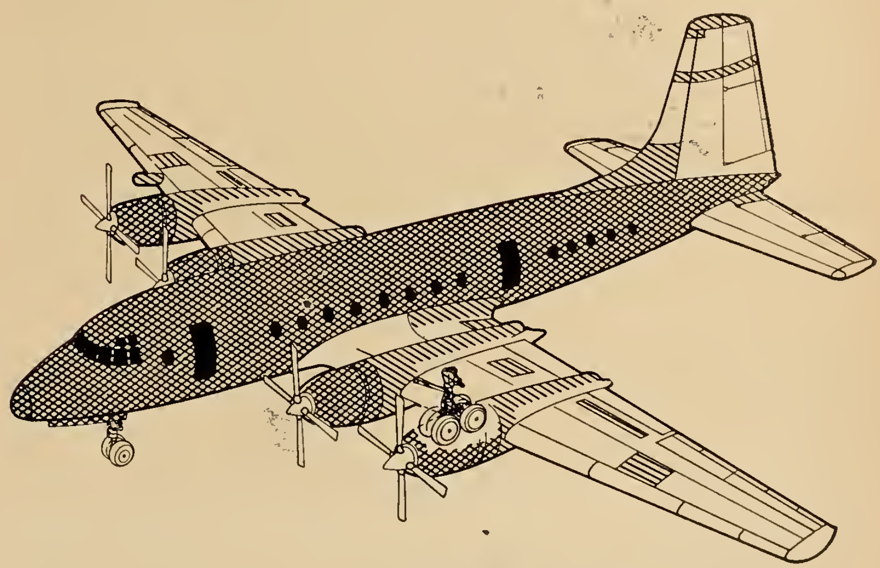
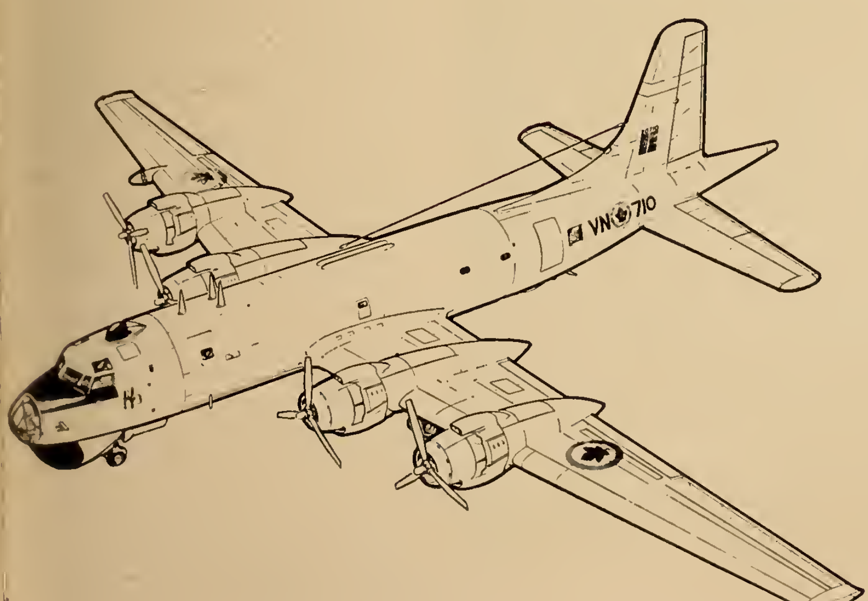


Fig. 3. Redesign Areas Britannia.

Fig. 4. Argus in Outline Form.



of the turbo-propeller type engine used in the Britannia. The engine nacelle afterbody lines are refaired as compared to Britannia since a gas turbine tail pipe is no longer used.

Aircraft Systems

A discussion of the adaptation of Britannia aircraft systems to the particular requirements of the maritime aircraft, and the complete original design of other systems which are necessary for military operation can become too involved in detail for the general scope of this article but there are three of the systems which are illustrative.

The Britannia hydraulics are designed around a 4,000 p.s.i. pressure supply and is entirely satisfactory in operation. However, practically all aircraft operated by the R.C.A.F. have 3,000 p.s.i. systems and stock supplies of pumps, pressure reducers, accumulators, fittings and lines are available in supply depots. In the interests of uniformity and long term experience, the hydraulic system was redesigned to a 3,000 p.s.i. base. At the same time the capacity of the system was adapted to a somewhat greater demand occasioned by additional hydraulically operated equipment such as bomb bay doors. A pneumatic power system which is not available in Britannia was designed, developed and utilized for sonobuoy ejection. (A sonobuoy is a type of submarine detection device). This latter system is somewhat unique inasmuch as it is the first time these particular stores have been power ejected.

The electrical power supply presents a problem of large magnitude. The Britannia power supply, sufficient for a civil aircraft, is entirely inadequate to meet the military demand. While security forbids detail mention of the various electronic devices installed in the aircraft some appreciation of the power requirements may be deduced from the knowledge that about 4,000 pounds of electronic and communication equipment requiring some 40 antennae are installed. Additionally, other aircraft services such as electrically operated controls, instruments, intercommunication speaker systems, lighting, etc., compound the power demand. A power generating system was therefore designed around a constant frequency 400 cycle a.c., 208/-120 volt three-phase power supply of 160 kva. capacity. Four, 40 kva. alternators each driven by an aircraft engine through a constant speed gear box, with complete fault protection and automatic paralleling and load division, in case of an alternator failure, comprise the main power source. Requirements for d.c. power are obtained by suitable transformation and rectification and an emergency battery powered circuit is incorporated for essential aircraft operating equipment. The 160 kva. power source in comparative terms provides sufficient electrical energy to serve about 60 average 6 room domestic dwellings, and the internal wiring of the aircraft if single stranded would cover a distance of about 60 miles.

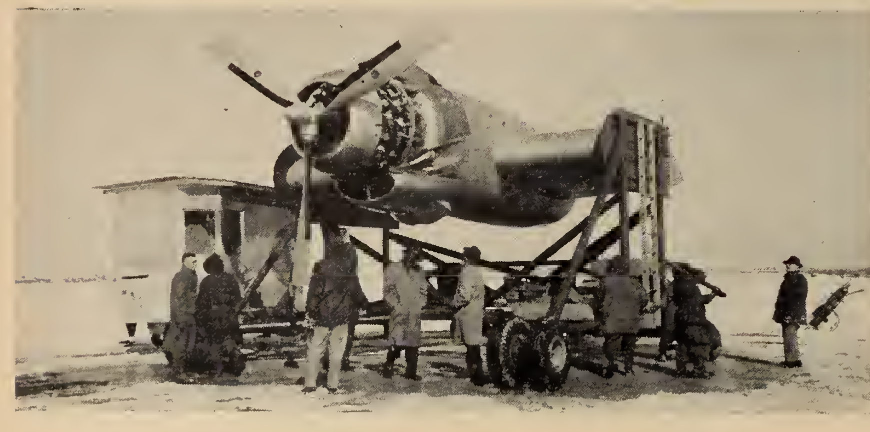


Fig. 5. Power Plant Ground Test Rig.

Fig. 6. Power Plant Ground Test Rig.

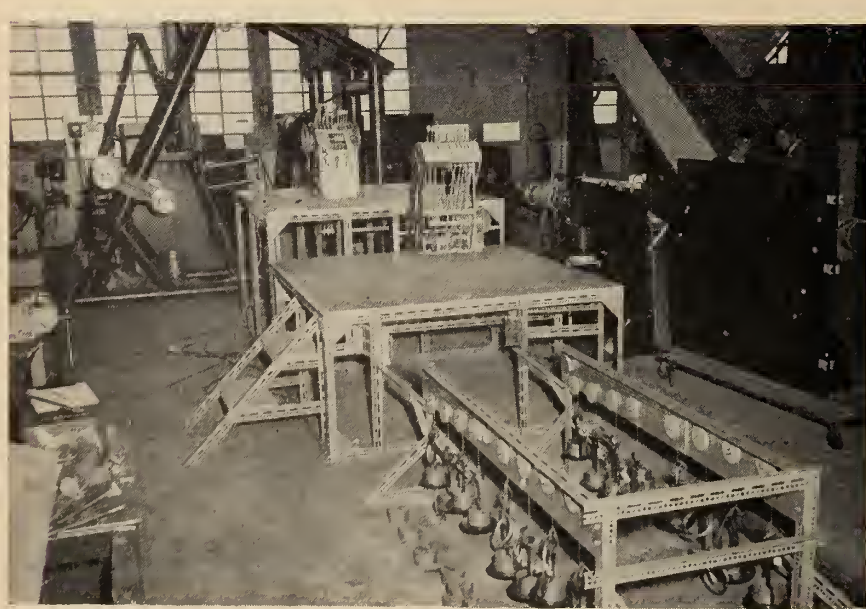


Fig. 7. Control Pedestals Test Rig.

The heating system provides heat for the aircraft cabin, and for the thermal anti-icing of wings and control surfaces. Since operation of the aircraft is required under all climatic conditions of temperature down to lows of -65° F. provision must be made for heat supply of large proportions. The civil Britannia having turbine type engines can tap engine air from the compressors as a heat source while the maritime aircraft having piston engines must have some other heat source provided. This is accomplished by the installation of four internal combustion heaters drawing fuel from the aircraft fuel supply. The four heaters have a capacity of 2,100,000 B.t.u. per hour, which again on a comparative basis would serve about 28 average six-room domestic dwellings.

Finally, on the subject of aircraft systems it can be appreciated that necessary military installations for armament, photography, search and detection gives rise to design and adaptation problems not encountered on a civil airliner.

Testing

The development and proving of airframe and systems for the maritime aircraft require a comprehensive program of model and full scale ground and air testing.

Model tests that have been made include wind tunnel, water tank ditching and metallized models for antennae radiation pattern determination.

Ground test rigs with actual aircraft parts and true simulation of loadings, component runs and cycling of operation are subjected to complete proving tests. Photographs of some of these rigs and test stands are shown.

A rigorous flight testing program worked out in conjunction with the R.C.A.F. specialist groups will be carried out on the first five to seven aircraft, and the program will run for a period of about two years.

Engineering Statistics

As an indication of the scope of the engineering program required to develop the aircraft some general statistics may be of interest.

(1) Approximately 18,000 engineering drawings are required to define some 70,000 detail aircraft parts and associated systems.

(2) Some 8,000 Bristol drawings with proper Americanization processing were utilized. The other 10,000 drawings represent the bulk of the engineering design effort.

(3) The engineering program was started in April 1954 and will be considered completed when the R.C.A.F. retires the last aircraft from active service.

(4) From the start of the engineering program to the first flight of the first aircraft represents an engineering manpower effort equivalent to about 1,000 man years. For a period of about one year manpower peaked at 530 of which 400 were direct charge.

The planning and scheduling of such a large engineering program is a major task in itself. The 18,000 drawings were broken down into about 2,000 packages, each of which could be clearly defined in terms of the problem and desired solution. The required completion date for each package was then established to match the manufacturing planning for the aircraft. Man hour estimates for each item were made and these data in conjunction with the established schedule date determined the assignment of engineering staff.

A continuous review and modification of the basic engineering sched-

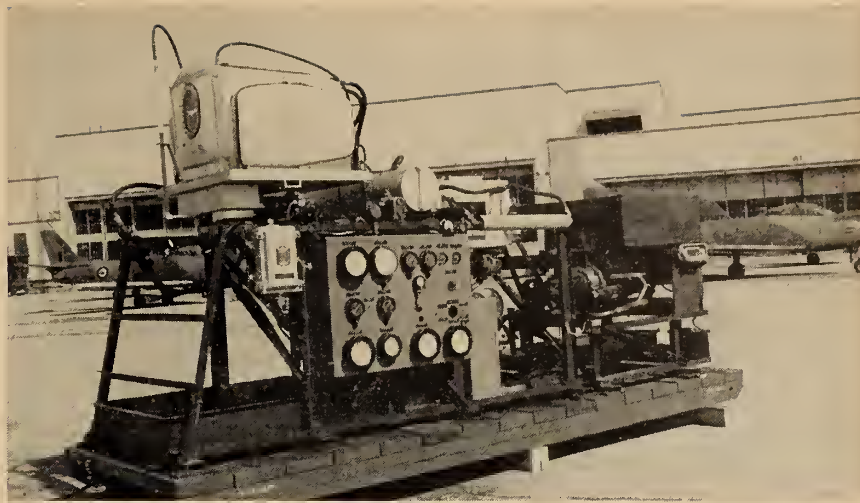


Fig. 8. Engine Oil System Ground Test Rig.

Fig. 9. Wing Fuel Tank System Test Rig.

Fig. 10. Wing Fuel Tank System Test Rig.

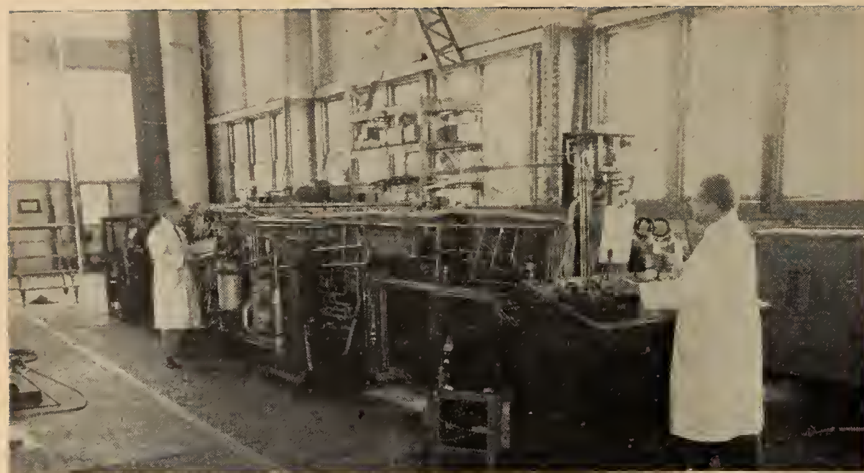


Fig. 11. Hydraulic System Test Rig.

Fig. 12. Main Landing Gear Retraction Test Rig.

ule was essential and inevitable. As the engineering program progressed various changes and modifications were requested by the customer, and some were developed by the contractor. As a result of this natural progression with time, over 400 major specification changes were negotiated and scheduled into the engineering program. This was accomplished without extending the aircraft completion date, but not without some pain, and with the wholehearted cooperation of the Canadair manufacturing division.

The manufacturing, completion and flight of the first aircraft within the originally scheduled dates are an achievement regarded with some pride by all of Canadair Limited.

Annual Meeting Papers

A limited number of copies of the text of the papers presented to the 71st Annual Meeting, at Banff, in June, are available from Institute Headquarters. (For convenience, application for any of these papers may be made on the business reply cards inserted in the *Journal.*) A list of the available papers is given below.

Allt-Na-Lairige Prestressed Concrete Dam
James A. Banks

The Peace River and Alaska Highway Gas Gathering System
A. L. Berry and B. L. Moreau

Design and Operating Features of the Canada-India Reactor, Bombay, India
F. J. Bleackley

Review of Current Winter Construction Practices
C. R. Crocker

Composite Construction of Bridges Using Steel and Concrete
Robert David and G. G. Meyerhof

Battle River Steam Station
J. N. Ford

Recent Expansion of Canadian Overseas Telecommunication Corporation Facilities
R. G. Griffith

Selection of the Trans-Canada Highway Route Through the Selkirk Mountains
J. P. Hague

Roof Structure of New Theatre for Stratford Shakespearean Festival
Charles Hershfield

Experiences in Tunnelling Saskatoon's Fourteenth Street Storm Sewer Through Glacial Deposits
D. R. Graham and N. L. Iverson

Future Power Development in British Columbia
T. Ingledow

Transverse Holding Grounds Without Piers
Russell J. Kennedy

Design and Operation of an Industrial Effluent Disposal System
J. C. Langford

Automatic Computing for Process-Unit Operating Guides
H. F. Moore

Some Effects of Fifth Harmonic Voltages, and their Mitigation, on the System of the Manitoba Power Commission
J. P. C. McMath and Paul Shane

Impact of Western Oil and Gas on the Canadian Economy
Carl O. Nickle

The Oak Street and Middle Arm Bridges
Lou Osipov

The Caland Project at Steep Rock Lake, Ontario
Philip D. Pearson

The Kelowna Floating Bridge
W. Pegusch

The Altitude Test Facility at Orenda Engines Limited
P. K. Peterson

Engineering the RCAF Argus
William K. Ebel and Everett B. Schaefer

Oil Exploration
Dr. J. G. Spratt

Air Pollution Control at a Nylon Intermediates Plant
H. R. L. Streight

Manufacture and Metallurgy of Flash-Welded Line Pipe
M. A. Scheil, G. E. Fratcher, S. L. Henry and E. H. Uecker

St. Lawrence Estuary Submarine Power Transmission System
O. W. Titus

A Major Power Plan for Yukon River Waters in the Canadian Northwest
J. M. Wardle

The Foundation Failure of the Transcona Grain Elevator

A. Baracos, M.E.I.C.

Department of Civil Engineering, University of Manitoba

THE METHODS of soil mechanics development in the past twenty-five years have made possible the determination of the ultimate bearing capacity of soils. The safety factor necessary for sound engineering practice precludes correlation of the ultimate bearing capacity with the analytical determination of the bearing pressures for the impending failure. Thus only on rare occasions when actual failure occurs is a correlation possible. The foundation failure in 1913 of a million-bushel grain elevator at Transcona, a few miles from Winnipeg, Manitoba, provides such an opportunity. It is the purpose of this paper to correlate the data on the foundation failure of the Transcona grain elevator with a recently completed field and laboratory soil mechanics investigation using the latest analytical methods.

At the Building Research Congress held in London, England, in 1951, a notable paper on "The Bearing Capacity of Clays" was presented by Dr. A. W. Skempton[1] The Transcona elevator failure was used by this author as one of his examples and is included in his table of "Field Data on Ultimate Bearing Capacity of Clays". The table, however, was incomplete as presented, with data on actual soil properties missing for two structures, one of them the Transcona elevator.

Another speaker on the same program as Dr. Skempton was R. F. Legget, M.E.I.C., Director of the Division of Building Research of the National Research Council, Ottawa. As he was speaking about "Special Foundation Problems in Canada", Mr. Legget also used the Transcona elevator as an example! In discussion, the desirability of completing the table in Dr. Skempton's paper was stressed. Mr. Legget thereupon promised at the meeting to expedite the study of this foundation failure. This paper prepared cooperatively by the Division of Building Research and the University of Manitoba represents the fulfilment of that promise.

Owing to the necessity of completing other outstanding soil and foundation studies, it was not until late in the summer of 1952 that the work herein described could be started. Only then was it found that some time previously two soil borings had been put down at the site of the elevator under the direction of Professor R. B. Peck, of the University of Illinois. Unfortunately, it was then too late to correlate the proposed Canadian investigation with Dr. Peck's work but it was decided to proceed as planned.

Dr. Peck has now published his results[2], accompanied by an eye-witness account of the failure by Mr. L. Scott White[3]. The investigation now to be described was rather more extensive than the American study, the two being generally complementary, agreement between the various test results being reasonably close, even though carried out quite independently except for a check by the author on a few of the soil samples obtained by Dr. Peck.

Although the foundation failure of the Transcona grain elevator occurred as long ago as 1913, the conditions involved have since frequently been discussed in connection with soil mechanics problems. The author describes a recent investigation made jointly by the Division of Building Research, N.R.C., and the University of Manitoba.

General Description of the Structure

Development of Canada's vast wheat lands in the early part of this century resulted in serious congestion of the Winnipeg railroad yards during peak periods of grain movement. Construction was therefore started in 1911 on the Transcona elevator in conjunction with one of the world's largest railroad yards to facilitate rapid grain movement and to give relief to the Winnipeg railroad yards.

The plan of the elevator is shown in Fig. 1. It consists of a dryer house 18 by 30 by 60 feet high, work-house 70 by 96 by 180 feet high, and the bin house 77 by 195 by 102 feet high, all constructed mainly of reinforced concrete. The foundation failure occurred under the bin house which was designed for storing one million bushels of grain. It consists of 65 circular bins arranged 13 in each of 5 rows running north and south. The 48 interstices between bins are also used for storing grain. A raft foundation, of reinforced concrete 2 feet thick, supports the bins and the conveyor tunnels under the bins. The depth to the bottom of the footings was 12 feet below the ground surface. The design bearing pressure was 6,600 lb. per square foot based on load bearing tests for which the data are no longer available. Dead weight of the bin house was very nearly 20,000 tons.

General Description of Soils

Greater Winnipeg lies in the basin of the glacial Lake Agassiz which existed during the recession of the Wisconsin ice sheet. Generally, in this area, the soils may be conveniently grouped as follows. The top 10 feet or less consist of relatively recent deposits of organic soils, flood-deposited silts and silty clays and outwash from higher ground, and modified lacustrine deposits. Under these are found 40 feet or less of glacial lake deposits forming two distinct layers of approximately equal thickness. The top layer is a brown clay and is distinctly varved with many fractional inch-thick layers of silt spaced between layers of clay ¼ inch or more thick. The bottom layer is a grey-coloured clay, softer than the overlying material and having numerous calcareous silt pockets and containing limestone gravel and stones at the greater depths. Beneath the clays are found glacial deposits of rock flour, silts, sands and gravel. The upper portions were deposited as the glacier receded and are underlain by subglacial drift which has been acted on by the full weight of the ice sheet. The subglacial drift is highly consolidated and supports many of the heavier structures in the Winnipeg area. The total thickness of the drift is about 10 feet but varies considerably from this value. The entire area is underlain by Ordovician limestone.

Description of Failure

The storage of grain in the bin house was begun in September, 1913, with considerable care taken to distribute the grain uniformly. On October 18, when 875,000 bushels of wheat were stored, a vertical settlement of a foot was noted within an hour after movement had been detected. The structure then began to tilt to the west and within 24 hours was resting at an angle of 26° 53′ from the vertical and the west side was 24 feet below its original position. The east side had risen 5 feet above original elevation. Eye witness accounts[3,4] stated that the structure acted monolithically with only a few superficial cracks appearing. Its coming to rest, approximately 24 hours after the movement began, corresponded with the cupola falling off the top of the structure.

It was reported that during the failure, the soil around the structure rose to a height of 5 feet above the ground surface around the entire bin house. Photographs taken after the failure show that the greatest upheaval occurred on the west side and was considerably more than 5 feet.

Calculations based on the dead weight of the bin house, 20,000 tons, and 875,000 bushels of wheat at 60 lb. per bushel, give a unit uniformly distributed pressure of 6,200 lb. per square foot on the clay when failure took place.

The operations to right the structure have been reported in detail by Allaire[5]. The structure has been in successful use since its position was restored.

Above: West side of elevator, showing tilt and soil upheaval. Below: East side following foundation failure; early stages of righting operations are shown under way. (Photos: Foundation Company of Canada Limited.)

Field and Laboratory Investigation

Figure 1 shows the location of seven test holes used to obtain samples for the laboratory tests. Holes 4 and 7 were sufficiently removed from the structure to avoid disturbances caused by the failure and the righting operations.

The remaining holes were located nearer the structure, some 60 feet from the bin house, in an effort to ascertain the effects of failure. It was realized, however, that these holes would show the effects of almost 40 years of continued pumping that has taken place since the bin house was righted. Pumping has been necessary to keep the bottom of the bin house dry. After righting, the bin house was approximately 34 feet below the prairie grade. It was not considered practical to place the test holes any closer to the structure as the entire area nearer the building was disturbed by tunnelling, excavation, etc., during the righting operations. To keep the bins dry, a 12-foot-deep trench had, in addition, been excavated around the bin house on all but the south side, further discouraging test holes any closer to the structure than those indicated.

The holes were bored to refusal at a depth between 40 to 50 feet where the dense and coarse glacial deposits were encountered. A diamond drill adapted for taking thin wall Shelby tubes 2 inches in diameter was used for boring and sampling. Samples approximately 2½ feet long were taken at 5-foot intervals or less where changes in soil were evident.

All samples were examined in the laboratory and notes made on colour, stratification, etc. On each sample, moisture contents, density, degree of saturation, and unconfined compression strengths were determined. On representative samples, grain size, Atterberg limits, undrained quick triaxials under constant load increments, specific gravity, and consolidation tests were performed. The unconfined compression and the undrained triaxial tests were performed on undisturbed samples trimmed to 1.5 inches diameter and approximately 3.0 inches long. Both the field and laboratory testing were conducted during the autumn of 1952 and winter of 1952-1953.

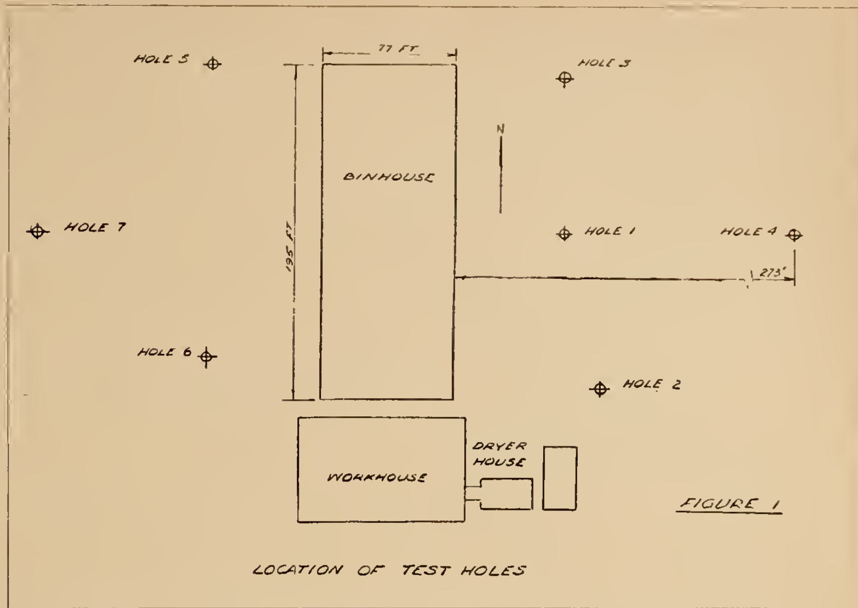


Fig. 1. Plan of the Transcona elevator.

Test Results

Typical results of the tests are shown in the Log of test hole 4, Fig. 3. No tests were performed on the material above 10 feet in holes 1, 2, 3, 5, 6, and 7 where fill placed during the righting of the elevator was encountered. Hole 4 showed the silts and silty clays as they probably were over the entire area prior to the excavation for the foundations.

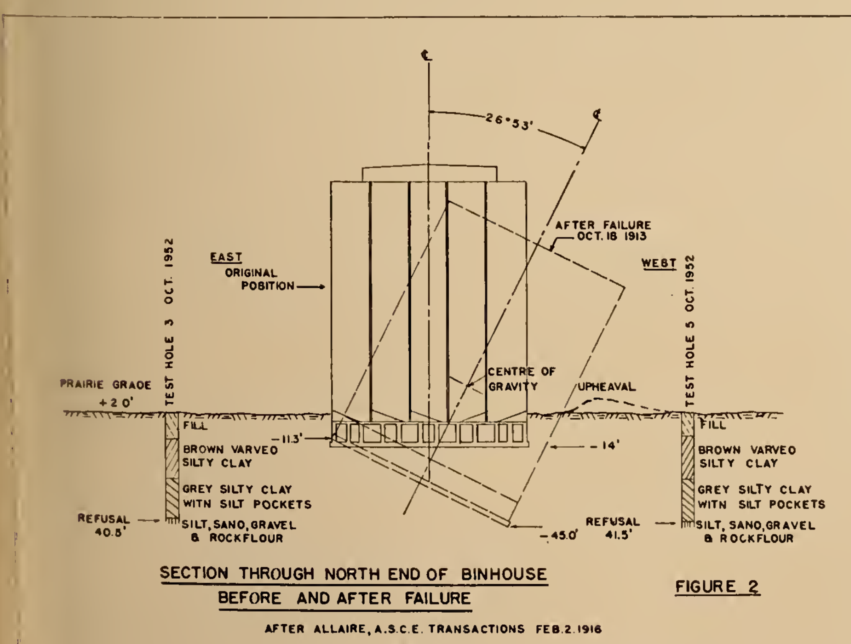
Below the 10-foot level to a depth of 20.5 feet in hole 4, and from 25 to 26 feet in the other holes, a brown highly stratified or varved silty clay was found. The stratification or varves were more or less horizontal and consisted of layers of silt of fractional inch in thickness between closely spaced layers of clay approximately ¼ inch thick. Average test results for this material were as follows:

Unconfined compressive strength (lb./sq.ft.)	2160
Liquid limit	85.3
Plastic limit	29.3
Moisture content (%)	52.4
M.I.T. grain size grouping (%)	
clay 49.4; silt	42.8;
sand 7.4; gravel	0.4
Unit weight of soil (lb./cu. ft.)	107

Under the brown silty clay to a depth of 40 to 45 feet from the surface, a highly plastic grey silty clay was found with numerous tan-coloured calcareous silt pockets and limestone pebbles. This material had about the same moisture content as the overlying brown silty clay and a lower unconfined compressive strength. In holes 1, 3, and 7 the bottom few feet of the grey silty clay were found to be very moist and soft. Holes 1 and 7 showed no distinct boundary between the grey silt and the underlying glacial drift. About 3 feet of a mixture of both materials formed a transition layer. Average test results for the grey silty clay excluding the very moist material encountered in holes 1, 3, and 7 and the transition layer were as follows:

Unconfined compressive strength (lb./sq.ft.)	1641
Liquid limit	75.9
Plastic limit	22.8
Moisture content (%)	49.9
M.I.T. grain size grouping (%)	
clay 38.7; silt	44.5;
sand 13.0; gravel	3.8
Unit weight of soil (lb./cu. ft.)	110

Because of the wide variation in the bottom grey silty clay and the transition layer, no average values are given.



All the samples below the 10-foot depth showed complete or near complete saturation. Twelve undrained triaxial tests on samples from hole 2 confirmed a negligible angle of internal friction for this type of loading. The consolidation test results (for samples from hole 4) indicate a decrease in compressibility with increased depth. Swelling pressures determined by permitting undisturbed samples to swell under a small load and determining the pressure required to return the sample to its original volume, range from 560 to 2050 lb. per square foot and are typical of the Greater Winnipeg clays which contain about 30 per cent of the more active clay minerals (montmorillonite). Preconsolidation pressures are not accurately determined on these clays but indicate that they are somewhat in excess of overburden pressures probably due to desiccation. The void ratio pressure curves are shown in Fig. 5.

The glacial drift was encountered at a depth of 40 to 45 feet. The change from material deposited during the recession of the ice sheet to the subglacial drift appeared to be indicated by a decrease in moisture content approaching or below the plastic limit. Up to 4 feet of the less dense drift were found. Boring refusal was encountered in the subglacial drift corresponding to the depth to which the north end of the bin house settled following the failure. Numerous stones prevented strength and consolidation tests from being performed on the glacial drift. The following data, however, were obtained:

Natural moisture content range (%) 10.0– 13.4
Moist density (lb./cu.ft.) 157. –143
Liquid limit, average 21.0
Plastic limit, average 11.9
M.I.T. grain size grouping (%)
clay (rockflour) 6.0; silt 33.6; sand 32.3; gravel 28.1

The test holes were not extended to the underlying limestone. Eight test holes bored by the owners of the building have shown, however, that the limestone bedrock was at a depth of approximately 50 feet.

Theoretical Bearing Capacity

The relatively rapid loading of the elevator on saturated clay corresponds to the laboratory undrained quick triaxial test for which the unconfined compression test is a special case. For such conditions it is recognized that the angle of internal friction is negligible and thus the cohesion is equal to half the unconfined compressive strength.

In general the ultimate unit bearing capacity of a soil may be expressed by:

$$q_u = N_c c + N_q y d + N_y y \frac{B}{2} \quad \dots\dots (1)$$

where q_u = ultimate unit bearing capacity
c = cohesion
y = unit weight of soil
B = width of footing
d = depth of cover on footing

For long continuous footings, the quantities N_c, N_q, and N_y are pure numbers depending on the angle of internal friction, ϕ. Their values are given in most modern soil mechanics or foundation texts.

For the special case of $\phi = 0$, N_q becomes unity and $N_y = 0$. The equation thus becomes:

$$q_u = N_c c + yd \quad \dots\dots\dots\dots (2)$$

Prandtl, in an early form of equation (2) evaluated Nc as 5.14 and Terzaghi[6] gives 5.7 for general shear failure and 3.8 arbitrarily for local shear failure. The general shear failure applies when the stress-strain curve (from laboratory tests) is of the type shown in Fig. 4a, or is approached when negligible variation exists in both loading and soil conditions.

For rectangular footings the value of Nc has been shown by analytical methods, model studies and a study of actual failures to be a function of $\frac{L}{B}$ and $\frac{d}{B}$, where L = length of footing. Recently, Skempton[1] has given the following formula:

$$N_c = 5(1 + B/5L) \, . \, (1 + d/5B) \quad \dots (3)$$

The theory for equation (1) assumes that the soil fails along a composite curve as shown in Fig. 4B. Although the theory is beyond the scope of this report, it may be noted that when ϕ = o, the composite curve extends to a depth below the bottom of the footing equal to approximately one-half the footing width. As failure commences, there is a rise of soil on both sides of the footing attributed to "edge action". Complete failure is associated with a further large upheaval on the side to which the building tilts.

Stability Analysis

A general examination of the actual failure and test data shows that the failure was consistent with the bearing capacity theory. The undrained quick triaxial test confirmed a negligible angle of internal friction. The composite curve along which the soil failed would have theoretically extended to a depth equal to about one-half the foundation width or 38½ feet below the bottom of the foundation. Since the dense glacial till occurred at approximately the same depth, it did not prevent the full development of this curve.

It may also be noted that the soil upheaval all around the foundations due to "edge effect" at the start of failure actually occurred. Allaire[5], reports an upheaval of 5 feet. Photographs confirm that further large upheaval consistent with theory occurred on the side to which the structure tilted. The actual direction of tilting is not important as even a very minor eccentricity in loading or variation in soil condition could cause a failure to either side.

The nearest test holes to the structure on the side of tilting were 63 feet distant and from the examination and testing of undisturbed samples, the soil appeared to be unaffected by the failure. Although the failure occurred nearly 40 years ago, it is not believed that the loss in strength of the soil resulting from the failure has been regained. Tests on similar Lake Agassiz deposits[7] do not indicate any extensive thixotropic strength regain for this material. Although no remoulded strength tests were performed, it has been generally found that remoulding results in a loss of one-half of the strength of the Winnipeg clays.

It is also reasonable to assume that because of the nature of the laboratory stress-strain curves and the precautions taken to assure uniform loading of the elevator, that the Terzaghi general shear conditions were satisfied. It is questionable, however, whether the assumption of local shear value (N_c = 3.8) would have been applicable had the stress-strain curves been different.

The undrained quick triaxial test confirmed that the angle of internal friction was negligible and that equa-

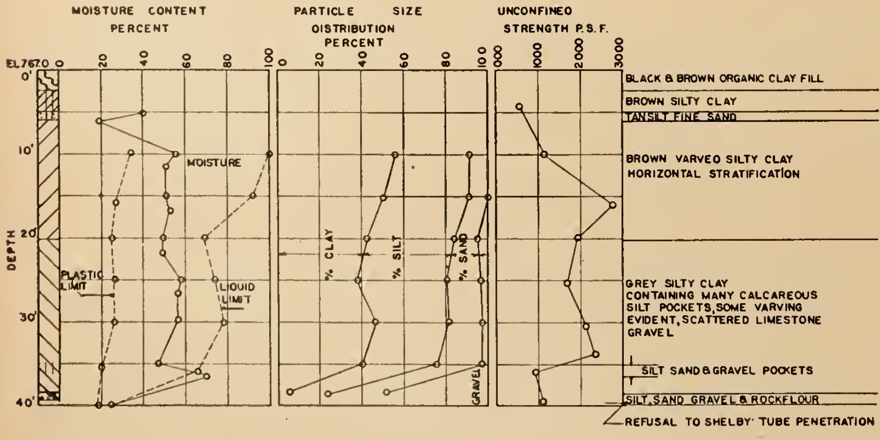


Fig. 3. Typical test hole log. (Test hole 4.)

tion (2) was valid. Substitution in equation (3) with:

$B = 77$, $L = 195$, and $d = 12$ (all in feet) gives $N_c = 5.56$. The ultimate bearing capacity is thus given by:

$$q_u = 5.56c + 12y \qquad (5)$$

It was difficult, however, to ascertain what value of the cohesion should be used in (5). The values for the brown silty clay or the grey silty clay alone would be unjustifiable high and low respectively since the failure plane passed through both materials. Use of the average unconfined compressive strength value of 1850 lb. per square foot for both the brown and grey silty clays from holes 4 and 7 appears the most justifiable. The same value for the remaining test holes 1, 2, 3, 5, and 6, nearer to the building, was 1933 lb. per square foot and probably reflects the effects of consolidation caused by the continuous pumping from under the bin house for a period of almost 40 years. Moisture contents and densities for the grey silty clay when compared for holes 4 and 7 with those of 1, 2, 3, 5, and 6, also indicate the effects of consolidation

	Holes 4, 7	Holes 1, 2, 3, 5, 6
Average moisture content (%)	51.9	48.9
Average moist density (lb./cu.ft.)	107.8	112.2

The average unconfined compressive strength values of 1933 lb. per square foot for holes 1, 2, 3, 5, and 6, and 1850 lb. per square foot for holes 4 and 7, do not include the low values from the 35- to 40-foot depth from holes 1 and 3, and hole 7 respectively. The difference in the values of cohesion, density, and moisture content mentioned, however, are small and could simply reflect statistical accuracy.

Results of substitution in equation (5) are shown in Table I. The unit weight, Y, of the soil covering the footings was taken as 107 lb. per cubic foot and the cohesion as half the unconfined compressive strength.

Discussion

The ultimate theoretical bearing capacity of 6420 lb. per square foot using the most justifiable value of unconfined compressive strength, 1850 lb. per square foot is remarkably close to the actual bearing capacity at failure of 6200 lb. per square foot. The correlation is even better than statistical considerations of the data

(continued on page 990)

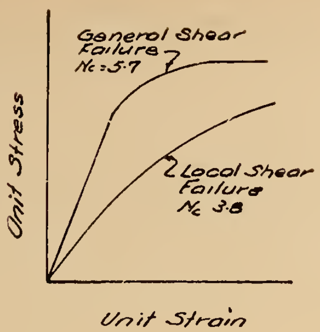


FIGURE 4A
Terzaghi Criteria for N_c

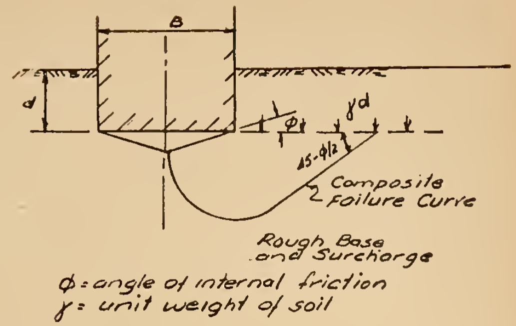


FIGURE 4B
Theoretical Composite Failure Curve

Figure 4.

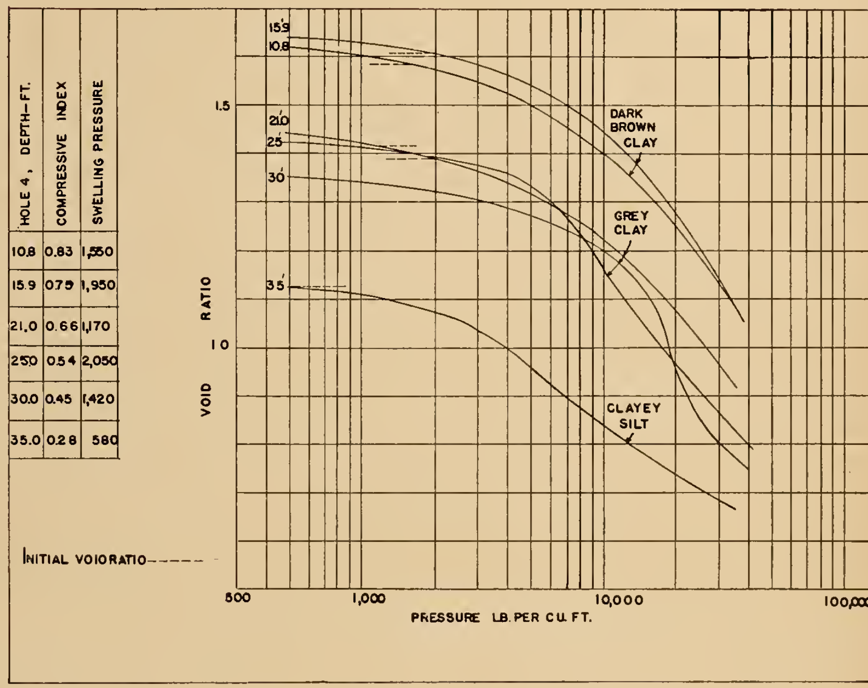


Fig. 5. Consolidation test results, hole 4.

Table I

Based on results for:	Average unconfined compressive strength (lb/sq.ft.)	"q_u" ultimate bearing capacity (lb/sq.ft.)
Brown silty clay — all holes	2160	7280
Grey silty clay — all holes	1641	5840
Brown and grey silty clay		
all holes	1933	6660
holes 1, 2, 3, 5, 6	1960	6730
holes 4, 7	1850	6420

Note: actual ultimate bearing capacity = 6200 lb/sq. ft.

Preliminary Estimates of Probable Maximum Precipitation Over Southern Ontario

J. P. Bruce

Department of Planning and Development, Ontario

ENGINEERS CONCERNED with the construction of dams for flood control and other purposes, have long sought a rational method of determining the maximum flood-producing capabilities of rivers. In many cases it is considered necessary to design spillways so that the discharge capacity will accommodate the maximum flood. This is especially true when high dams are constructed upstream from urban centres, and earth-fill construction is used. In these cases overtopping of the dam would likely result in failure and subsequent loss of life and property damage.

It is possible to approach the determination of the maximum flood of a watershed area in several ways. One common method is to apply large safety factors to the greatest flow recorded during the period of record on the stream. Another approach is to try to estimate, by statistical methods, a flow magnitude of sufficiently long return period from the flow records available. A third method is to begin with estimates of the maximum rainfall (or rainfall plus snowmelt) likely to occur over the basin, and by means of infiltration indices and design unit hydrographs convert to maximum flow. This study is concerned with providing the basic data for a determination of the third type, and contains estimates of the physical upper limits to rainfall that could occur over Southern Ontario.

Statistical techniques fail us in this problem, even though we may have up to 100 years of rainfall records at a station within a watershed. It is possible to assess, from the 100-year record, the number of inches of rain that will occur, on the average, once every 100 years (100-year return period storm) at the station. However, as Court[1] has shown, the chance of a 101-year return period storm occurring within any given 100 years is 63 per cent. Thus, there is a 63 per cent chance that a structure, designed for the 100-year return period storm, will have its capacity exceeded during its lifetime, if built to last 100 years. In order to have a 95 per cent confidence that a 100-year structure will not be overtaxed in its lifetime, it should be designed for a 1950-year return period flood. The impossibility of accurately assessing a storm or flood magnitude of such a return period from 10 to 100 years of records by a statistical approach, and the inadequacy of even a 95 per cent confidence in a structure, the failure of which could not be tolerated, makes a study of probable maximum precipitation, based on storm rainfall data and meteorological theory, an essential part of establishing design criteria for flood control structures.

The United States Army's Corps of Engineers has recognized this, and has supported the Hydrometeorological Section of the U.S. Weather Bureau since 1938, to perform such studies. "Standard project storm" studies are also conducted by the Hydrometeorological Section to aid in the design of river structures for which something less than the most stringent criteria may be applied. Several U.S.W.B. publications[2,5], give isohyetals of maximum rainfall across the southern part of Ontario. However, it has been found that these lines were drawn by geographical extrapolation, and that the meteorological conditions peculiar to Southern Ontario were not considered to any great extent in their construction. That is, these estimates were not intended for use in this province.

Method

The Hydrometeorological Section's pioneering maximum precipitation studies[3,4,5] outline techniques applicable to parts of North America to which the "generalized estimates" of the U.S.W.B. do not apply directly. The basis of the method is storm transposition and maximization. The idea of storm transposition is to increase the meteorological experience of the area studied, by considering not only severe storms which have occurred in that area, but also storms which occurred in meteorologically similar adjacent areas. After studying these storms and analysing the rainfall that accompanied them, maximization techniques seek to determine by what percentage the actual storm rainfall could have been increased by physically possible increases in the meteorological factors which affect the rainfall volume.

There are two basic types of upward adjustments applicable to storm rainfall amounts to obtain probable maximum figures. One is an adjustment for higher moisture content of the rain-producing air mass involved and the other is for maximum mechanical efficiency of the storm. The latter type of maximization has been found to be impracticable for three reasons given by Paulhus and Gilman[6].

(1) Little is known of the structure of storms and the factors controlling their efficiency, so the problem of maximization is very difficult to approach.

(2) Major observed storms have undoubtedly produced heavy preci-

pitation because of their high efficiencies rather than high moisture charge. Thus a fairly long record of storms over, or transposable to, the area concerned, should provide one or more of near maximum mechanical efficiency.

(3) "It is generally suspected that the maximum efficiency of a storm is realized when the moisture charge is not a maximum." Thus moisture maximization is likely an over-adjustment for this factor and compensates for absence of adjustment to mechanical efficiency.

The moisture adjustment technique is discussed at length in the U.S.W.B. Hydrometeorological Report No. 23[2]. The basic concept involved is that, assuming a saturated atmosphere with pseudo-adiabatic lapse rate, the moisture content of the air mass is a single valued function of the 1000 mb. dew point. This type of moisture and temperature distribution is closely approached in areas of marked convergent flow and upward motion of the air, as are found near storm centres. This distribution also represents the maximum moisture content of air, of given 1000 mb. dew point, which is undergoing lift to produce precipitation.

The moisture charge of a unit column of air can be determined in terms of precipitable water which is defined as the equivalent linear depth of water in the unit column if all water vapour is condensed. It is given by

$$W_p = \int_0^{P_0} \frac{q}{g\,w}\,dp$$

where q = specific humidity
w = density of water
P_0 = pressure at bottom of air column
g = accel. of gravity.

A graphical solution, assuming a saturated pseudo-adiabatic distribution, in terms of 1000 mb. dew point is available in many publications[7,8,2]. However, precipitable water is really a misnomer as no natural precipitation process removes all the moisture from the air.

The amount of water that can be precipitated from a column of air is known as the effective precipitable water (W_e). W_e is a function of the assumed flow pattern and is indeed a measure of the efficiency of any flow model postulated, when the model is varied at constant dew point. It has been found, however, that the ratio of W_e's at two different dew points is practically independent of the inflow-outflow model, and also that this ratio is very nearly that of the W_p's at the dew points in question (2). From the graphical solution of the equation above a curve giving the effective precipitable water at any 1000 mb. dew point as a percentage of maximum W_e (at dew point 78° F.) has been obtained[2].

Ontario Storm Types

The storms which have produced greatest rainfalls in Southern Ontario in the past, and are most likely to do so in the future, fall into two main categories. These are: (I) "decadent" tropical storms, and (II) thunderstorms formed by squall lines or cold fronts, or within moist, potentially unstable, hot air masses. In the U.S. Hydrometeorological Section report No. 2, on the Ohio Basin above Pittsburgh, it was found that for short durations and small areas, type II storm is most effective in producing heavy rain, but for large areas and longer durations, the type I storm provides greatest rainfall depths, in this area.

The subject of this paper is of particular interest at present to hydraulic engineers, in view of recent unprecedented storms such as Hurricane "Hazel". The paper is reproduced by permission of the Director, Meteorological Branch, Department of Transport.

The thunderstorm type is a midsummer phenomenon and generally follows an unusually hot and dry period. Interception and initial loss of rain to infiltration are likely to be at a maximum. The tropical storm type is dealt with at some length by Mason[9] who studied the twenty-five former hurricanes which passed over or near Ontario between 1900 and 1949. He found that of these, eight were of extraordinary severity and that the common feature of each was that they moved inland as hurricanes into regions of substantial horizontal temperature gradient. If this temperature gradient was strong enough to define a frontal zone, the storms became intense frontal lows. These circumstances produced the most devastating storms of record in Southern Ontario. Outstanding examples are the storms of September, 1878, August, 1915, September, 1932, and October, 1954, but complete listings since 1900 are given in Mason's study. The north-south quasi-stationary front or slowly moving cold front is thus an essential feature of any major storm in Ontario of tropical hurricane origin. Therefore, light to moderate persistent precipitation in the vicinity of such a front is very likely to produce abnormally low initial infiltration rates, for the fall season, prior to the major cyclonic centre's passage. In summary, the run-off to rainfall percentage for the tropical storm type will be much higher than for the summer thunderstorm type due to higher antecedent precipitation and to a general decrease in the initial infiltration loss and interception as the autumn season progresses.

Available Storm Data

The U.S. Corps of Engineers has for some years now supported studies of the rainfall of major storms which have occurred in the United States. The results of this work are found in "Storm Rainfall in the U.S."[10], which gives depth-duration-area (D.D.A.) data for some 500 storms. The D.D.A. data are in tabular form and give the maximum observed rainfall for areas of 10 sq. mi. to 70,000 sq. mi. and durations of 6, 12, 18, 24, etc., hours for each storm studied. Unfortunately, no such studies of Canadian storms have been conducted, except for a very few by the U.S. Weather Bureau. This is a serious difficulty in attempting to estimate probable maximum precipitation. However, a preliminary solution has been arrived at by using the information for pertinent storms reported on in "Storm Rainfall in the U.S." and performing an analysis of the rainfall of the most severe storm on record in Ontario, storm "Hazel" (Oct. 14-15, 1954).

Analysis of Storm "Hazel"

A full description of the meteorological aspects of this storm has been given by Knox[11] and an account of the associated precipitation patterns by Thomas[9]. Suffice it to note here that the period of really intense precipitation north-west of Toronto, from 1800-2400 hours on October 15, occurred as a frontal low (which Knox calls Hazel II) spawned by the hurricane (Hazel I) and passed northward through Southern Ontario at a rate of about 50 m.p.h.

The depth-duration-area analysis

of the rainfall of this storm was accomplished by first constructing isohyetal charts for 48, 36, 24, 12 and 6-hour precipitation. The official records[9] were augmented by the field survey observations taken by Dr. D. V. Anderson of the Ontario Department of Lands and Forests, immediately after the storm in the northern sections of the Humber Watershed and adjacent areas. The figures given by Anderson which were used are shown in Table A.

Reports 1 and 2 corroborate each other to within one inch, as, by matological observers giving 12-hour precipitation amounts and occasionally beginning and ending of rainfall were obtained by the Meteorological Division for the storm period. Synthetic mass curves of rainfall[13] were constructed for each of these 33 locations using the special reports and shaping the curves in accord with the hourly rainfall intensities observed at the nearest continuous recording gauge. Examples of the results of the technique applied to Snelgrove and Bradford for storm "Hazel" were given by Thomas[9]. This procedure was also followed for 4 first-order stations which had reported 6-hour precipitation amounts.

From the mass curves it was found that for the central 5,000 square miles contributing to the depth-duration-area (D.D.A.) values, the intense rainfall for 6, 12, 24, and 36 hours was within two hours of being simultaneous. As two hours is within the possible error of construction of the synthetic mass curves and as the problem in hand was the determination of maximum precipitation, it was decided to plot the maximum rainfall intensities at each station for each duration in the construction of the isohyetal charts.

These charts were then planimetered, and calculations performed as in Table I. The results were plotted on semilogarithmic paper and enveloping curves drawn (Fig. 3).

Table A. Field Survey Observations — Hurricane "Hazel"

	Rainfall (inches)	Remarks
(1) Thompson Lake A	7.6± 0.2	In tub set out 151745E
(2) Thompson Lake B	12± 1	45 gal. drum empty 13th
(3) Nobleton	9± 1	Cement trough empty 14th
(4) Richmond Hill	8± 1	Garbage pail empty 15th a.m.
(5) Cedar Mills	8± 1	Pail empty 15th a.m.

1745E, 3.4 inches of rain had fallen at Malton Airport. This suggests that the total 48-hour rainfall at Thompson Lake (north-east of Bolton) was about 11 inches and this figure was used. Number 3 was taken to be a 36-hour fall and numbers 4 and 5 were taken as 18-hour amounts as the rain in this area ended about midnight on October 15. Report No. 1 led to an acceptance of 7 inches as the maximum 6-hour rainfall amount at Thompson Lake. It is interesting that the U.S.W.B. Technical Paper No. 2[12] noted that unofficial reports, such as Anderson's, usually are about double those of the nearest first-order station. The Malton 48-hour rainfall was 6.03 inches, and that given for Thompson Lake is 11 inches. Malton was the closest first-order station to the centre of heaviest rainfall.

The 48-hour rainfall chart was obtained by plotting official Canadian rainfall amounts for the two "precipitation days" October 14-15 ending at 8 a.m., October 16, Anderson's figures above, and U.S.W.B. figures for stations along the south shores of Lake Erie and Lake Ontario. These two days cover the period of maximum rainfall intensities for all areas contributing to the D.D.A. values. The construction of isohyetal charts for 36, 24, 12, and 6 hours were based on reports from the continuous recording gauges in operation at Guelph, St. Thomas, Kitchener, London, Toronto, Malton, and St. Catharines.

Special reports from 33 regular cli-

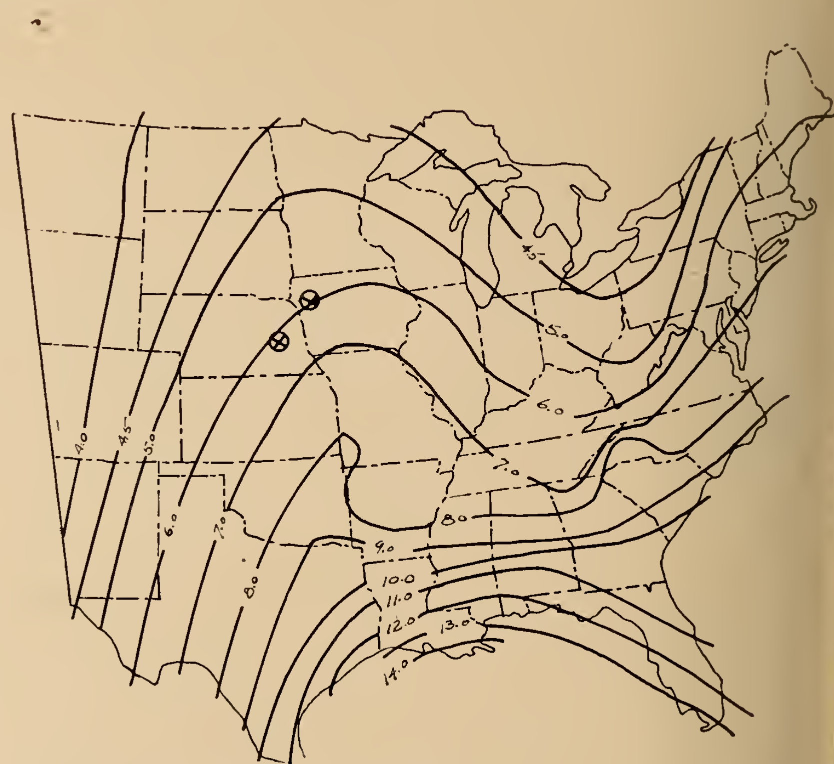


Fig. 1. 24-hour rainfall (in.) to be expected once in 100 years. (After Yarnell)

Table I. Computation of Depth-Area Curves from 48-hour Isohyetal Map ("Hazel")

(1) Isohyet. (in.)	(2) Area Enclosed Plan reading	Area sq. mi.	(3) Net Area Square miles	(4) Average depth rainfall (inches)	(5) Volume of rain increment (3) x (4)	(6) Inches per sq. mi. cumulative	(7) Average depth rainfall (inches) (6)/(2)
11	.01 (4)	7.8	7.8	11.2	87	87	11.2
10	.10	56	48	10.5	504	591	10.6
9	.30	168	112	9.5	1,060	1,650	9.8
8	.64	358	190	8.5	1,610	3,260	9.1
7	1.07	600	242	7.5	1,810	5,070	8.5
6	3.37	1,890	1,290	6.5	8,390	13,460	7.1
5	10.91	6,110	4,220	5.5	23,200	36,660	6.0
4	25.94	14,500	8,490	4.5	38,200	74,860	5.2

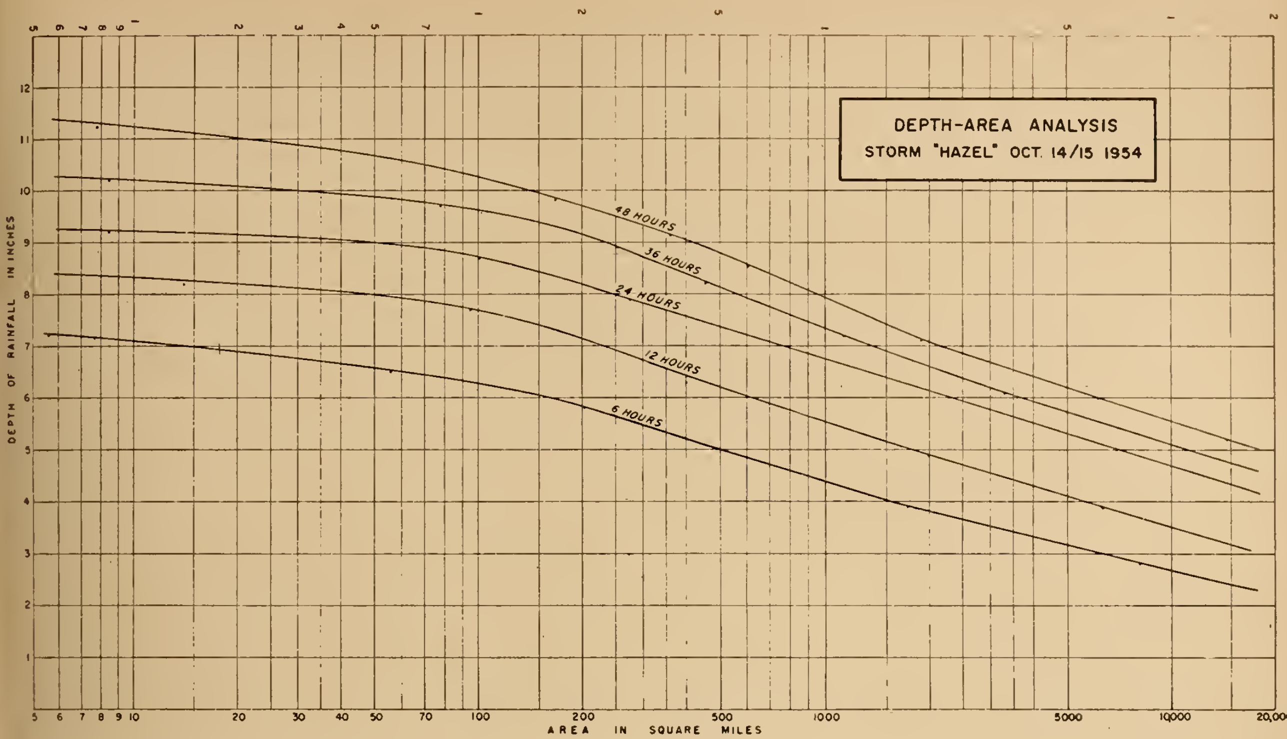


Figure 2.

Other Storms

The storms, other than "Hazel", considered here, are reported on in several publications. The only other "decadent tropical storm" of intensity to compare with that of October, 1954, was the September, 1878, storm, which caused widespread flood damage in northern Ohio. The heavy rainfall area of this storm extended into Southern Ontario. Accounts of this storm and depth-duration-area data may be found in references (4) and (10).

Of the thunderstorm occurrences analysed in "Storm Rainfall in the U.S.", four were found to yield limiting depth - duration - area figures when maximized and transposed to the Michigan peninsula area (and by implication to Southern Ontario). These occurred at (i) Beaulieu, Minn. and Ironwood, Mich. July 18-23, 1909, (ii) Cooper, Mich. Aug. 31-September 1, 1914, (iii) Stanton, Neb. June 10-13, 1944, and (iv) Baydon, Iowa, Sept. 17-19, 1926.

Transposition Limits

The question to be answered when considering the transposition of any of these U.S. storms to Ontario is, "could a storm of this type and similar mechanical efficiency occur over Ontario?" To answer requires a study of several corollary problems. (1) Do subsiding currents of dry air aloft, on the east side of the Rocky Mountains, combined with low level flows of moist hot air directly from the Gulf of Mexico, produce widespread and intense potential instability conditions in the mid-western United States not possible over Southern Ontario? (2) Do the Great Lakes exert a significant influence on low level instability of very moist air with trajectories over them, and thus inhibit thunderstorm activity to some extent? (3) Should the location of such storms with respect to the general circulation patterns of the hemisphere impose a limit on the distance over which they may be logically transposed? These are problems which are largely unsolved scientifically and the present state of meteorological knowledge allows answers only on the basis of synoptic experience of weather situations, and climatological data.

From these two points of view, the Sept. 1878 hurricane-spawned storm could very easily have centred over Southern Ontario with little change in intensity. It was very similar to storm "Hazel" and the heaviest reported rainfall was 12.2 inches in 24 hours, 15.0 inches in 66 hours. The only factor affecting its transposition to Ontario is latitudinal. McCormick[14] has found that for areas of 500 to 5,000 sq. mi. and periods of 24 hours and greater, observed rainfall amounts decrease by 2 per cent per degree of latitude north of 30 degrees North in this continent. For smaller areas and shorter periods the factor is very slightly less than this. This reduction of rainfall depths northward from 30° N is attributed to two factors:

(1) The decrease of possible maximum moisture content of the tropical air mass as it is further removed from the Gulf of Mexico or Atlantic source region, and

(2) The decrease in possible maximum vertical velocities, which is associated with the decrease in theoretical and observed maximum horizontal wind speeds in the troposphere, north of 30 degrees North, as discussed by Rossby[15].

The moisture adjustment of this storm will be discussed in the next section. The latitudinal adjustment made was a reduction of 5 per cent (for 2½ degrees) for transposition of the heavy rainfall centre to Southern Ontario.

The transposition of the four thunderstorm occurrences requires more difficult decisions. The Cooper, Mich., storm was one which is of a common type in Ontario, and the warm sector in which the precipitation occurred passed over southern Lake Michigan and was thus subject to whatever stabilizing effect the passage over a section of the Great Lakes might have. Thus this storm has been considered completely transposable to Ontario, and has been adjusted only for moisture content as discussed below ("Moisture Adjustments").

Storm (1), at Beaulieu, Minn. and Ironwood, Mich. occurred during July when the Great Lakes' effect on stabilizing the lower levels of a hot, moist air mass would be at a maximum. However, as there is some doubt as to the significance of this effect on storms giving rainfalls as great as these, and as the consideration here is one of maximization of rainfall, it was decided to consider this storm directly transposable to southern Ontario.

The remaining two storms occurred in the mid-western section of the U.S. wherein the first factor mentioned under "Transposition Limits" (above) has an effect on the maximum precipitation possible in the area. There is a very marked difference in observed precipitation figures and various return period storm intensities calculated therefrom, between the Nebraska-Iowa region on the one hand and the Michigan peninsula-Ontario area on the other. This is illustrated clearly in Yarnell's[16] chart for 24-hour rainfall to be expected once in 100 years. This is reproduced as Fig. 1 with the locations of the Nebraska and Iowa storms marked. While the synoptic weather situations which produced these two thunderstorm series are not unknown in Ontario, it is clear that the rainfall production capabilities of the region in which they occurred is significantly greater than that of southern Ontario. Thus the storms have been considered partially transposable to Ontario. That is, the storm rainfall amounts have been increased to the maximum for the area in which they occurred by a moisture adjustment, and have then been transposed to Ontario by the application of a reduction factor. This factor is an index of the ratios of rainfall production capabilities of the mid-western U.S. and Southern Ontario. It was derived from the ratio of 100-year return period point rainfall of the two regions in question (4.0 in./6.1 in. from Yarnell's chart). As a check on Yarnell's figures, the most recent figures of 100-year return period point rainfall for stations in Iowa were averaged and yielded a figure of 6.5 in. To check the Ontario figure, the Gumbel distribution[22] was applied to the precipitation data for Toronto for the period 1900 to 1955. This gave a 100-year return period rainfall of 3.9 in. Thus the ratio 4.0/6.1 does not appear to be an excessively low index for transposition of these storms to Ontario.

Moisture Adjustments

The adjustments to maximum moisture content for the U.S. storms were facilitated by several references[17,18] and by unpublished U.S. Weather Bureau charts giving monthly figures for maximum 12-hour persisting dew point reduced pseudo-adiabatically to 1,000 millibars (mb.). To assess the maximum moisture content possible in an area for a given period of the year, it is necessary to obtain a maximum dew point below which the dew point did not fall during a 12-hour period, in order to eliminate one-hour readings which are nonrepresentative of the moisture content of the general air mass.

The theory of the moisture adjustment is discussed under "Method", above, the net result being that the ratio of moisture content of the air at the maximum 12-hour dew point, at the time of year the storm occurred, to the moisture content at the observed storm dew point (assuming saturated pseudo-adiabatic lapse rates in both cases) gives the moisture adjustment factor for the storm. By multiplying the observed storm rainfall by this factor the maximum rainfall possible in a storm of the mechanical efficiency of the one which actually happened, can be obtained.

For the four thunderstorms the adjustment factors are given in Tables II and III.

The Sept. 1878, hurricane-type storm latitudinal adjustment has been discussed. The storm dew point was 71° F. and the maximum dew point for Ontario during September is 73° F. The moisture adjustment factor is then 1.10 and is partly compensated by the 5 per cent reduction for latitude, to give a final adjustment factor of 1.05. It will be noted that for the storms of Table II no difference in latitude need be adjusted for, and for the storms of Table III, a latitudinal adjustment is included in the index of transposition.

Moisture Adjustment—Storm "Hazel"

For storm "Hazel" the maximum storm dew point was not readily available and had to be obtained directly from the weather observations taken during the storm.

This was done in the manner recommended by Paulhus and Gilman[12]. A study was made of the dew points reported in surface synoptic observations during the period in which rainfall intensities were greatest, i.e. 150001 E to 152400 E. Hourly reports were then consulted for the stations whose reports were considered to be most representative of the inflow stream of tropical air to the storm in the North-eastern Pennsylvania Central and Western New York States area. The temperature of the dew point below which no dew point observations fell in a continuous 12 hour period (the 12-hour persisting dew point) most common to this area when reduced pseudo-adiabatically to 1,000 millibars (mb.) was 65° F. The upper level radiosonde reports for the area of the storm warm sector, which were also examined, in

Table II

These storms were considered directly transposable to Ontario.

Storm location	Date	Storm dew point	Ontario maximum dew point	Adjustment factor
Beaulieu, Minn. and Ironwood, Mich.	July 18-23, 1909	71°F.	74°F.	1.16
Cooper, Mich.	Aug. 31-Sept. 1, 1914	68°F.	73°F.	1.28

Table III

These storms were considered directly transposable in part by application of factor 4.0/6.1 = 0.66

Storm location	Date	Storm dew point	Storm location maximum dew point	Storm location adjustment factor	Ontario adjustment factor
Stanton, Neb.	June 10-13, 1944	70	76	1.34	.88
Boydon, Ia.	Sept. 17-19, 1926	70	75	1.28	.81

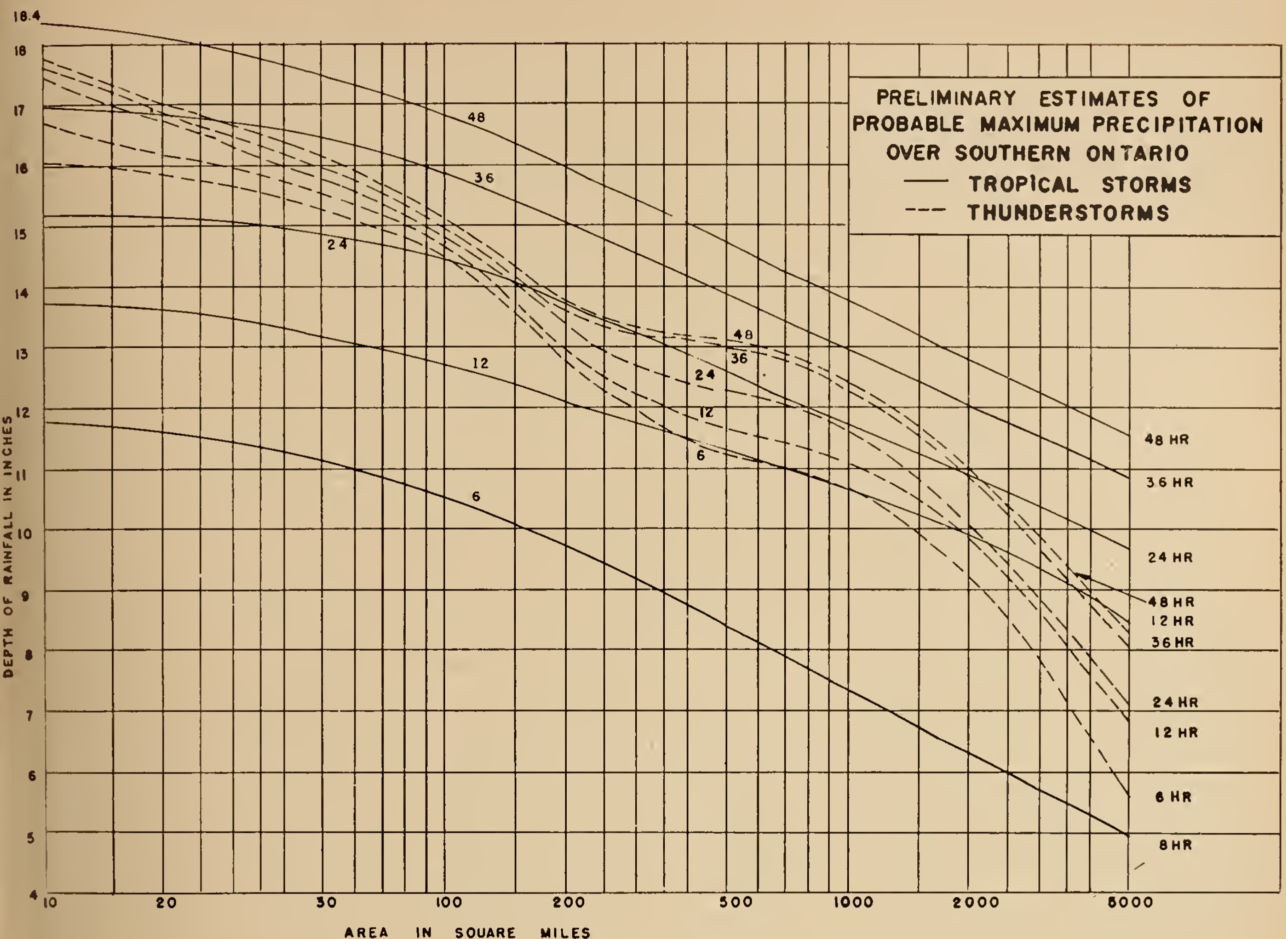


Figure 3.

dicated that a low level wet bulb potential temperature of 18° C. was most representative of the warm air mass at latitudes of Southern Ontario west of the Appalachians (see Buffalo report for 151500Z). A wet bulb potential temperature of 18° C. corresponds to a 1,000 mb. dew point of 64.4° F. at saturation. With this close agreement, 65° F. was accepted as the representative storm dew point.

The U.S. Weather Bureau figures for maximum persisting 12-hour dew point for the hurricane season (Aug.-Oct.), were checked by an analysis of dew points at Malton airport for the period of record available on the Canadian Meteorological Service's punched cards (1952-1955). This analysis confirmed the U.S.W.B. figures.

A frontal cyclone such as storm "Hazel" in its second phase[11] requires a frontal system with temperature contrasts too great to occur in August. One estimate of the available temperature contrast for the production of storm energy over Ontario gives for August only 64 per cent of that which is possible in October. In September, the temperature contrast approaches that possible in October. The maximum persisting dew point for the period Sept.-October was thus taken on the index of the maximum possible moisture content of a storm such as "Hazel". This dew point is 73° F. and the resulting moisture adjustment factor is 1.48.

Correction Factor—Storm "Hazel" Rainfall

A difficulty arose in connection with the analysis of storm "Hazel" which has led to the conclusion that the observed precipitation figures for the storm were somewhat low. The trouble was that estimates of the volume of runoff on the East Branch of the Humber River, closely approached or exceeded the amount of rainfall observed in the area. It seems likely that for a 48-hour rainfall, of which only the last 6 or 8 hours were of extraordinary intensity, the actual runoff percentage must have been somewhat less than 100 per cent. This suggests that either the volume runoff estimates are high or the precipitation figures low. A probable source of error in the rainfall figures is obvious, namely the effect of wind in decreasing the catch of rain gauges. This may be true in the case of the five other "controlling storms", but insufficient data is available to make an allowance for this factor in these cases.

A number of attempts have been made to evaluate quantitatively the effect of winds of various speeds on the catch of rain gauges[19,20,21] although to my knowledge no experimental data of this sort is available for the Met. Service of Canada standard rain gauge. Of the figures available, those most applicable to the present problem were obtained by Bornstein and quoted by Abbe[19], by Hudleston, quoted by Brooks[20] and by various experimenters quoted by Wilson in his discussion of Black's paper[21]. Application of the figures to the hourly precipitation and wind data at Malton yields percentage corrections of 17½, 15 and 20 to be added to the observed rainfall figures. (Note: where necessary the wind speed was reduced from anemometer level to gauge level by an expression of form

$$\frac{U_1}{U_2} = \left(\frac{Z_1}{Z_2}\right)^n$$

where n = 1/7 for neutral stability
U_1 and Z_1 are wind speed and height at level 1 and
U_2 and Z_2 wind speed and height at level 2.

As these three correction factors are in close agreement considering the difficulty of assessing such a measurement error, the average correction factor was taken as 18 per cent.

As available wind reports indicated that the velocities reported at Malton were representative of those which occurred within the heavy rainfall area, and as the light rain was accompanied by light winds and the heavy rain by strong winds, it was considered feasible to apply this constant correction factor to the total storm rainfall figures. Thus the 18 per cent correction factor was applied to the depth-duration-area data for storm "Hazel" before adjusting the figures for maximum moisture content of the rain-producing air mass.

Final Probable Maximum Precipitation Estimates

For each area and duration, the greater of the maximized rainfall figures for storm "Hazel" and for the Sept. 1878, storm, is entered in Table IV. The greatest depth for each area and duration, based on the four thunderstorm occurrences, is shown in Table V.

Enveloping curves of these tabulated values are given in Fig. 3.

Assumptions and Limitations

A recapitulation of the assumptions stated or implied in this derivation of probable maximum precipitation is essential here. These assumptions can be classified into two groups, those which are inherent in this type of hydrometeorological study, and those which were made for this preliminary study. The general assumptions of the storm maximization-transposition technique are: (1) that the probable maximum precipitation can be derived from the optimum combination of moisture charge and convergence of the wind; (2) that a storm (or storms) of record have approached the maximum in mechanical efficiency over or near the area being considered; (3) that the moisture content of the rain-producing warm air is a single valued function of the 1,000 mb. dew point in intense storm areas.

The particular assumptions made in this study are: (1) that frontal lows formed by tropical hurricanes and thunderstorm occurrences will produce maximum rainfall depths over Southern Ontario, (2) that at least one of the six storms considered was of near maximum mechanical efficiency, (3) that the latitudinal variation of precipitation factor of McCormick's is applicable in the Great Lakes area.

Discussions of the validity and limitations of most of these assumptions appear in the text, or in references.

Certain limitations on the applicability of these figures should be kept in mind.

(1) They are *preliminary estimates* and should be considered as such until such time as complete reports, preferably for individual basins, confirm or deny their validity.

(2) They are intended to apply to latitudes near that of Toronto. Areas further south would likely require the use of slightly higher estimates and for regions further north in Southern Ontario slightly lower figures would likely be applicable.

(3) Long term climatic trends which would affect these estimates have not been evaluated as they are much beyond the scope of this report. It is interesting to note, however, that the long-term trend of annual precipitation at Toronto is slightly downward.

(4) It is likely that maximum volume flows for many Ontario streams would result from spring runoff, but it is unlikely that peak flows for a spring freshet would exceed that produced by precipitation of the intensity of the probable maximum rainfall (see (2) below).

Suggestions Regarding Further Studies

The obvious requirement for the future is for complete studies of probable maximum precipitation over individual basins in Southern Ontario. This would involve studies of maximum snow melt, of all other possible controlling storms that have occurred in or near the region, of the effect of local basin topography on maximum rainfall and of the relationship of the basin's shape to the orientation and distribution of rainfall patterns of controlling storms. In addition, the seasonal variation of maximum rainfall should be studied.

However, to permit complete studies of this nature, considerable work must be done on the following: (1) depth-duration-area analyses of major storms of record in Ontario; (2) determinations of maximum snow melt in conjunction with maximum spring rainfall for individual basins in Southern Ontario; (3) augmentation of the present Ontario meteorological observation network to include more precipitation stations, snow measuring locations and temperature-humidity stations. The requirement for additional continuously recording rain gauge installations is especially urgent; (4) effect of winds of various

(Continued on page 990)

Table IV. Probable Maximum Rainfall From Hurricane-Formed Storms

Area sq. mi.	Duration (hours) 6	12	24	36	48
10	11.8	13.8	15.2	17.0	18.4
100	10.4	12.7	14.5	15.9	16.9
200	9.8	11.8	13.6	15.1	16.0
500	8.3	11.0	12.3	13.5	14.6
1,000	7.1	10.6	11.6	12.7	13.6
2,000	6.3	9.9	10.9	12.1	12.8
5,000	4.9	8.4	9.7	10.8	11.5

Table V. Probable Maximum Precipitation — Thunderstorms

Area sq. mi.	Duration (hours) 6	12	24	36	48
10	16.1	16.7	17.5	17.5	17.5
100	14.5	14.5	14.5	14.5	14.5
200	12.8	12.8	13.4	13.4	13.4
500	11.2	11.7	12.3	13.0	13.0
1,000	10.7	11.1	11.6	12.3	12.3
2,000	9.2	9.9	10.1	10.9	11.0
5,000	5.6	6.8	7.1	8.1	8.3

The Problem of Stream Pollution

A Panel Discussion Organized by the Chemical Section, The Engineering Institute of Canada, November, 1955.

The extent of pollution of Canadian streams, the scientific knowledge of its effects, the trends of legislation, and the efforts of industry and government to deal with the problem were discussed at a panel meeting organized by the Institute. The following version is an abstract of the proceedings that is intended to give an account of the main topics.

Introduction

Lucien Piché

Director of the Department of Chemistry, University of Montreal, Member, Fisheries Research Board of Canada.

With the present rapid development of urban life and with the amazing growth and multiplication of industries, there has grown the awareness that the legendary great volume of our rivers may no longer be adequate to absorb the ever increasing amount of water-borne wastes poured into them.

Pure water is an exceedingly fragile material; it takes only little foreign matter to make it unfit for domestic or industrial use. In order to appreciate this, let us consider that normal sanitary domestic sewage, as foul, dangerous and repulsive as it may be, is still 99.9 per cent water; it is not so remote, in chemical composition at least, from so-called "pure water". Therefore, the issue of pollution of water cannot be lightly dismissed on the grounds that industrial wastes and municipal sewage can adequately be disposed of by dilution and spontaneous purification in our rivers. All sewage can and must be rendered innocuous and all industrial effluents can and must be made acceptable before they find their way into running water and it has become a modern common practice in populated areas to effect a minimum degree of purification before releasing foul waters. It is estimated that 60 per cent of the domestic sewage discharged into sewerage systems in United States is partially or completely treated and a considerable portion of the industrial wastes is also treated to various degrees, either separately or in combination with domestic sewage. Ontario now has 175 municipal sewage treatment plants in operation.

The most common type of pollution of water is caused by the discharge of wastes that contain organic substances either in suspension or in solution. Inorganic wastes are not uncommon, but the organic type of material predominates in domestic sewage and in most industrial wastes, and it includes a large variety of materials and bacteria; all of these, of course, have an objectionable effect on the quality of the water and on its use for domestic or industrial purposes. This organic matter may be present in coarse or fine suspension or in solution and it is composed primarily of carbohydrates, of fats and of proteins. The coarse, and a portion of the finely divided materials settle more or less rapidly to the stream bed, forming sludge deposits that modify its physical and biological character. The finely divided matter remaining in suspension imparts turbidity to the water and it increases the cost of its treatment for domestic or industrial use for it bears directly on the necessity and efficiency of filtration. The oils and fats spread on the surface, forming unsightly sleek, while the remainder may remain in suspension, depending on the velocity of the stream, a continuous or semi-continuous film may prevent normal surface aeration of water over large areas.

Soluble impurities impart taste and odors to the water; in some instances very little quantities of them become highly objectionable; phenols, at concentrations of 1 part in 5 million parts of water are highly undesirable on account of the strong chemical taste that they impart to the water when it is chlorinated before domestic use.

It is, however, in their indirect effects that organic waste materials contribute most to the pollution of water, for the discharge of sewage or of wastes sets into motion a complex chain of chemical, biochemical and biological events, the objective of which is the elimination of the pollution. This is called *autoepuration*, in which bacteria play a very prominent role.

Unpolluted stream water has low bacterial counts. But the numbers of native water bacteria increase greatly and rapidly in response to the addition of food materials to the water, particularly carbohydrates or proteins. These organisms consume the organic substances that they find in water, and combine them with oxygen to produce the energy for their life processes and to multiply in numbers at exponential rates if the food supply is adequate. A number of industrial wastes are ideal forms of food to sustain bacterial growth and while industries do not, as a rule, directly contribute to the bacterial flora of water, their organic wastes are prime factors in the establishment of septic conditions in a river. This responsibility is not generally recognized by industry but it becomes very great, when, as is usually the case, sewage at the same time greatly increases the density of pollutional bacteria, among which there may be present certain pathogenic organisms of intestinal origin such as typhoid or dysentery bacteria.

These microorganisms, as a group, are known as coliform bacteria; their count in waters presumed to be polluted is closely watched because their determination is the best bacteriological index of faecal pollution of water, and is a prime concern from the point of view of public health. For the supply of a modern waterworks, a raw water containing coliform organisms in density greater than 5000 per 100 ml cannot be adequately treated by the ordinary process of coagulation, filtration and chlorination. A water heavily contaminated with any type of native or pollutional bacteria is inadequate for cooling or as process water because of slime formation.

The objectives for river water quality that have been adopted by the Ontario Pollution Control Board have set at 2.500 coliform bacteria per 100 ml of water, the maximum allowable limit; in Quebec, the Ministry of Health does not generally authorize the use of raw water for the feeding of a municipal filtration plant if it frequently contains coliform bacteria in excess of 3000 per 100 ml; in extreme cases, it will authorize the use of water containing up to 5000 microorganisms on the condition of a double chlorination. That is, chlorination of the raw water, filtration and chlorination of the filtered water.

The reaction by which microorganisms break down and utilize organic matter is known as "*biological decomposition*"; oxygen is consumed in large quantities in this decomposition. If oxygen is available in sufficient amount, stable final products such as carbon dioxide, water, nitrates or sulphates will result from biological decomposition and no septic conditions are likely to appear. If the oxygen is not sufficient, it will first be entirely depleted and the stream will become septic; the active natural life of the stream will be destroyed by the toxic nature of the compounds produced by this type of decomposition.

Oxygen, then is the vital element for biological decomposition of an organic waste, including bacteria. Water will dissolve oxygen from the air up to relatively small concentrations to attain saturation. The saturation value depends on the temperature of the water, since more oxygen will dissolve in cold than in warm water, but it is close to 8 or 10 p.p.m. at ordinary summer temperatures and at altitudes neighbouring sea level, that is to say only 60 to 80 pounds of oxygen per million gallons can dissolve in water.

The rate at which oxygen will diffuse into water from the air after it is partially or wholly depleted is a surface phenomenon depending on a number of physical factors, the principal of which is the area of surface exposed and its renewal; reaeration of water therefore largely depends on stream agitation. The more quiet the water, the slower is the rate of diffusion, until in quiescent water, an equilibrium is established, even at low concentration, at which diffusion almost ceases beyond a film of saturated water on the surface.

Industrialization, frequently accompanied with the construction of dams on turbulent segments of rivers usually modifies substantially the pattern of aeration of water in substituting pools of quiet water for falls or rapids. The blanketing of rivers with ice during winter evidently cuts out the possibility of any aeration of water, a factor which becomes a major one in this country. On the other hand, some inorganic materials such as sulphites or ferrous salts are strongly reducing in nature and effluents containing them have an important I.O.D., *immediate oxygen demand*, entering into this pattern of oxygen balance.

In a polluted stream, deoxygenation will decrease the oxygen content of the water, whereas reaeration will tend to increase it. The net result of these two opposing processes on the actual dissolved oxygen level of the stream will, of course, depend on the quantity and nature of the polluting materials in relation to the stream flow and the rate of reaeration.

Concentrations of dissolved oxygen in water are closely watched in the evaluation of the state of pollution of a stream. Oxygen is determined by the Winkler method which is relatively easy to carry out; it is a particularly dependable method and semimicro modifications enabling the determination on 25 cc. of water are becoming popular. It should be carried out at least in its initial phase immediately at the point of sampling since agitation of the water with air will rapidly modify the oxygen content of the sample. Kits for field use are quite simple and easy to use. Concentrations of oxygen are expressed either in p.p.m. or oxygen or frequently as a percent of saturation.

The ability of an effluent to consume oxygen from water is measured and expressed in terms of its biochemical oxygen demand (B.O.D.), that is the amount of oxygen that will spontaneously be used up in a sample of water or of diluted effluent when it is incubated for five days at 20 deg. C. This is an empirical test carried on under standardized laboratory conditions simulating the biochemical oxidation in streams and it is a measure of the amount of oxidizable organic matter present in the sample. Comparing B.O.D.'s of industrial wastes with the average B.O.D. of a domestic effluent leads to an expression of their pollutional effect in terms of a population equivalent. A sulphite mill for instance, producing 300 tons of chemical pulp daily is considered to be equivalent to a population of 250,000 to 400,000, whereas a beet-sugar factory would come to be equivalent to 100,000 people in its pollutional load. In a number of cases, industrial wastes are reported to have a pollutional effect much greater than the local population and as a result of the combined action of both, certain rivers or sections of rivers are subjected to volumes of wastes far beyond their capacity.

However, B.O.D.'s, with oxygen content and coliform counts are the main standbys in stream surveys. But, under certain conditions, more information is required than that available from these main determinations. Determination of oxygen consumed from permanganate or from chromic acid will complement the B.O.D. index in establishing the total amount of oxygen necessary to effect a more complete oxidation of relatively stable organic materials; nitrates, nitrate or ammonium salts may be determined in some cases where nitrogen balance becomes of special interest; pH is frequently a useful index of dilution of acidic or basic materials; colour and hardness are routinely checked in municipal water works.

Methods for all these chemical, biochemical and bacteriological determinations in water or in effluents have been standardized by the American Public Health Association and their code of procedures is the well known "Standard Methods for Water Analysis" which is periodically revised. There are some good texts on Stream Survey or Industrial Waste Treatment Practice, the best known of which are Eldridge's book first published in 1942 and the more recent American Chemical Society monograph edited in 1953. Interpretation of analytical results requires a certain minimum experience since the characteristics of different waters varies so much that it is impossible to lay down absolute standards to which all safe or adequate waters must conform.

Control of Pollution by Pulp and Paper Mills

Douglas Jones, AFFIL.E.I.C.

Executive Secretary, Technical Section, Canadian Pulp and Paper Association.

Under the impact of promising long term influences it is to be expected that the Canadian pulp and paper industry will continue to expand its productive capacity. This expansion can be affected only by the most efficient use of the existing natural resources of the country. For pulp and paper production these are fuel and power, wood fibre and water.

Generally speaking, fuel and power resources are in adequate supply. Surveys indicate that wood is available for present production on a perpetual yield basis and that additional supplies are available for future expansion. With respect to water supply the industry is in a fortunate position as compared with other countries.

Production of one ton of newsprint requires about 1.0 cord of wood; 90 to 100 horsepower days of electrical energy; 600 lbs. of coal; and the use of 35,000 to 45,000 imperial gallons of water.

Water — A Natural Resource

The pulp and paper industry shares with others the right to use our natural resources. To all, water is a natural resource. This concept is perhaps somewhat novel in Canada, though widely accepted in the United States and Europe. It involves the recognition that maximum benefits would accrue to the nation through its most effective use. This in turn requires consideration of its use for power, navigation, fisheries, domestic and industrial water supply; and of the maintenance of the resource so that it may be available as a recreational asset.

For full utilization as a natural resource, its potentials must first be fully assessed. Most rivers and river systems in Canada have been comprehensively surveyed for their power potential. It is doubtful if they have been studied from an overall viewpoint. Such a survey would determine the flow characteristics of the stream, its normal pollution load as measured in terms of solids, oxygen demand, etc., the individual effect of existing dams, industries and communities, and would predict from the hydrologic data and pollution load what the water quality and quantity would be at any point along its course.

The pulp and paper industry accepts this concept of water resource utilization. It recognizes that by the nature of its operations, it is intimately concerned with the problem of maximum water utilization. Its operations are but one of many other potential sources of pollution.

Survey to determine the capacities of rivers for the handling of industrial wastes is a task which must be undertaken by industry and government working together.

In the pulp and paper industry the three major operations each present different problems in control of pollution and the problems are technical as well as economic. These operations are wood preparation, pulp production, and paper manufacture.

Pollution caused by wood preparation has been, or can be eliminated.

Pulp production is either mechanical or chemical. In mechanical pulping, pollution would be caused by residual quantities of very fine and almost microscopic particles, or at the other extreme, by very coarse particles of the groundwood. Control is achieved with specially designed and expensive equipment, which refines the coarse particles to sizes of use for paper, while saveall and recovery equipment — sometimes in conjunction with chemical treatment—make it possible to retain the fines. Suspended matter in effluents can now be controlled to quantitative limits substantially below what they used to be.

The only way to really determine the effect of the recoveries is to test survey each case and thereby establish whether, in fact, the percentage of fibre content at minimum flow is, or is not, harmful.

In chemical pulping, pollution is caused by the chemical content of spent liquors which contain most of the chemicals used to dissolve the wood and thereby isolate the cellulose. They also contain in solution such quantities of the non-cellulose constituents as are removed. Mills using the sulphate or soda digestion processes now concentrate, burn and recover practically all the chemicals in them. Techniques generally used have eliminated harmful pollution wherever stream flow has been adequate, except for controllable amounts.

It is unfortnate, but nevertheless true, that in spite of intensive research on sulphite liquor utilization there is still a problem arising from most, if not all, sulphite pulping operations. The problem is two-fold: first that of developing an adequate and economic process for the concentration and burning of the liquid to recover chemicals and heat, and second, that of developing from the liquor by research other materials or products having a volume market. Some new sulphite mills have been designed to use soluble bases such as magnesium, ammonia or sodium and the problem is less difficult. However the soluble bases may never find general application, for economic reasons, though Canadian mills are experimenting with them.

The problem is being approached from three broad points of view: viz, modification of cooking processes and the obtaining of higher pulp yields; the continued search for a recovery process for calcium base spent liquors; and the development of commercially useful and marketable products from the non-cellulose or lignin content of the spent liquors.

Advances in techniques and equipment have resulted in minimum quantitative use of chemicals, and a yield of 65 pounds of pulp from 100 pounds of wood, for certain grades of paper. Any such gains represent a reduction in quantity of polluting material in spent liquor.

The development of commercially useful products from spent liquors is perhaps the most realistic and practical approach. However, we are dealing with chemical substances of baffling complexities and in very large volumes. To date no one product whose potential market is anywhere nearly equal to the quantities dealt with has been found. Fundamental studies on this challenging problem are in progress.

Paper mill effluents contain minute fibre particles and some mineral fillers. But fibre and filler content can be determined and controlled.

The Canadian pulp and paper industry is one of the major users of our water resources for power and for industrial purposes. In such a position, the industry recognizes its obligations. On the basis of its performance to date in tackling the problems of industrial water usage, and on the basis of its contribution to the economy of Canada and to the communities in which mills are located, the industry can expect that all levels of government will recognize its problems. Such recognition has been accorded in the past. Cooperation and understanding must be maintained between industry and society represented by government. The former must be given time to solve the technical and economic problems involved, and government may expect a cooperative attitude to the work of government bodies.

And coupled with these two requirements, we believe there is a third, which is that some use of rivers for disposal of industrial waste and therefore some "pollution" must be permitted in an industrial nation. It would seem that the minimum degree of pollution from all sources at any given moment is one of the prices to be paid for industrial activity.

The pulp and paper industry which is conscious of the immensity of the problem and has already done much to minimize its pollution load, will continue its efforts and will work cooperatively toward the establishment of reasonable standards after thorough and accurate surveys have been made. However, any general prohibition of the use of streams for mill effluents would destroy the competitive position of Canada's largest industry resulting in damage to Canada's international trade not only in value of export but also in the use of dollars earned on exports and with which we buy much needed imports. It would result in the closing of mills, loss of employment to a labour force of approximately 250 thousand and the ultimate decline of Canada's forest heritage.

Pollution Control in a Petroleum Refinery

H. H. Clare

Engineering Division, Imperial Oil Company, Limited.

Since petroleum products have never been particularly cheap in Canada, loss control programs have always ensured a measure of pollution control. Sooner or later we arrive at a point where the capital cost of loss control equipment shows no economic return for the reduction in losses achieved. It is at this point that we enter the era of pollution control. The responsibility for pollution control is widely recognized as a normal cost of doing business in this age.

Imperial Oil Company's abatement program was formalized in 1943 by the formation of a central refinery loss committee. Detailed reports by each of the nine refineries are made semi-annually to this committee, on losses sustained, and plans formulated to reduce losses and control pollution. This committee constantly studies methods and equipment to improve refinery losses. At each refinery a loss committee meets monthly to study loss reports and recommend improvement measures.

To cooperate fully with government bodies, our company inaugurated efforts for pollution abatement in Ontario and Alberta. Some time ago discussions were held between the four major petroleum refiners to determine if a similar group study could be made in Montreal East. Considerable enthusiasm was shown for a concerted pollution study.

The biggest problem of oil refiners in respect to water pollution is to keep oil out of the streams. To prevent oil leaks from finding their way into streams, all sewers that carry oil and water must pass through a large settling basin before entering a stream.

You would think that it would be a relatively simple matter to separate oil and water since oil is lighter, and then skim the oil off the surface. This is not the case. All types of products, from light gasolines to heavy asphalt are produced in a refinery. When the heavy oils get into the sewers, they mix with the lighter products, the water, and any solid particles present and form very stable emulsions. These emulsions are about the same gravity as water and as a result are very difficult to separate and recover.

The second big problem for refineries, as in chemical plants, is the disposal of used and unwanted chemicals. These chemical wastes may have an adverse effect on the aesthetic qualities of the waters as well as on their physical and chemical properties. Their health significance is considerably secondary to sewage, but they may seriously impair the use of water for domestic, recreational and industrial purposes.

One of the most widely used chemicals in oil refining is caustic soda. In water, this increases the emulsifying tendency of oil and water, which causes higher oil losses. Phenol is another bad actor, when it finds its way into rivers and streams. It has a high B.O.D. and will kill fish and other marine life if too high a concentration is allowed to contaminate a stream. A third nasty chemical is hydrogen sulphide. Fortunately, most of the hydrogen sulphide ends up in the refineries' own furnaces and flares. However, some of it becomes dissolved in water, creating a hazard and pollution problem.

There are methods and equipment used to combat the various forms of potential water pollution. First and most effective of these is a vigorous program of good housekeeping in the plants to prevent unnecessary leaks of oil into the sewers, good designing and cathodic protection of lines.

Diversion of clean process water from oil contaminated water is carried on, to reduce the velocity through the oily water separator.

Imperial builds circular separators for all new construction. There is a 120-foot.-diameter separator at Montreal East. A sour-water deodorizer tower, started up in 1955, was designed to strip 3,000 lbs. per day of hydrogen sulphide from 2100 barrels a day of sour water. Exhaust steam at 15 p.s.i.g. is used to strip out the noxious gas in a conventional gunite lined stripping tower.

Spent caustic soda from treating operations is accumulated in tankage and is no longer allowed in our refinery sewer system. For the trace amounts that do escape, fresh sulphuric acid is added to the sewer to control the pH of the separator effluent as close to 7 as possible.

Phenols are not a major problem at our Montreal East refinery but they were to our Sarnia refinery. A very novel method is used at Sarnia to destroy phenols. Living organisms, such as rod shaped bacteria consume the phenols and convert them into harmless carbon dioxide and water.

A modern waste disposal plant at Montreal East consists of two stages of centrifuging to remove solids from mixtures of slop oil, water, and solids. It was designed to handle 900 barrels per day of sludges. A multi-hearth furnace capable of handling 24 tons per day incinerates the separated oil-soaked solids, leaving only harmless ash behind. A smoke-eye ensures smokeless operation.

In overcoming major disposal problems, Imperial will have improved the quality of effluent beyond reasonable criticism. The cost has been well over $1 million in Sarnia and over $500,000 in Montreal. That is a lot of money, but money willingly spent by our Company to be a good citizen in any community.

The Importance of Stream Pollution Legislation

D. S. Kirkbride, M.E.I.C.

Development Manager, Canadian Industries Limited.

From an industrial point of view we should be particularly concerned about the type of legislation which may have to be implemented in the future to deal with the increasing problems that accompany industrial expansion. Since countries such as the United Kingdom and the United States have reached industrial maturity before us, we can benefit from their experience.

The evolution of legislation has been related directly to population growth, to increased industrialization and to improved standards of living. The pattern has usually begun with the introduction of legislation to protect some specific interest.

With continued population growth and increased industrial activity the need for conservation of water supplies, the problems of interstate and interprovincial streams, the financial burden of limiting pollution, and the high technical effort necessary to devise methods for dealing with pollution problems all accumulate and create major problems of conflicting interests. Legislation directed at specific issues such as public health, navigation, etc., becomes more and more inadequate for resolving these conflicts and a comprehensive approach must be found for dealing with them. Canada is just entering a stage where it must start examining the adequacy of its present legislative machinery.

The United Kingdom in 1951 passed what is called the "Rivers Act". This act deals with the overall problem of pollution, the establishment of standards for effluents, new discharges to rivers and streams, and with tidal waters. The administration of the act has been assigned to a number of River Boards. These boards, authorized in 1948 under the River Boards Act, are responsible for dealing with questions not only of pollution but also of land drainage, fisheries, and the conservation of water in an entire river basin or group of rivers. The River Boards are moving carefully and purposefully to set up their standards and methods of operation and are consulting freely with industry, local authorities and all agencies affected.

In the United States, approximately 40 of the 48 states have regulations dealing with the pollution of streams. Many of these have now been broadened to consider the wider implications of overall pollution matters though some are still far from adequate. In roughly 30 of these, there is provision for cooperation with industry.

In spite of the best efforts of state authorities, the pollution problem reached such magnitude in recent years that the United States federal government intervened in 1948. The Water Pollution Control Act passed at that time called for federal aid in research, technical advice, establishment of standards and similar matters. The passing of this statute had a considerable effect and prompted many of the states, who had become concerned about states' rights, to improve their legislation, and in some instances to join together in interstate compacts for the control of pollution along interstate rivers or streams.

Along with these measures there have been many instances of cooperative effort involving industry and all levels of government where satisfactory improvements in serious pollution conditions have been brought about.

In Canada, legislative responsibility for different aspects of pollution is divided between the federal and provincial governments by virtue of the authority delegated to each under the B.N.A. Act. The federal government exercises control over navigation, commercial fishing, migratory birds and international and coastal waters. The provinces are responsible for public health and other matters.

In the provincial field all the provinces except New Brunswick and Prince Edward Island have legislation. All eight acts specifically prohibit pollution in one form or another or classify pollution as an offence and specify penalties. In all but one there is provision for regulation of waste disposal.

If there is fault to find with this situation, the fault is not with the people responsible for administering these matters, but rather with the fact that conditions are changing and the overall problems are becoming more than the present legislative machinery is designed to cope with.

In recent years, Canada's growth and industrialization have been creating new situations. More comprehensive legislation and understanding of the overall problem are required.

In Canada some provincial authorities are concerning themselves with the overall problem of conserving their water resources. Two provincial administrative bodies exist to deal with overall pollution problems: the Pollution Control Board of Ontario and the Provincial Sanitary Control Commission in Manitoba. Investigation of the problem is under way in Quebec.

In at least two regions there is pressure developing for interprovincial authorities to administer the watershed of interprovincial streams.

Saskatchewan and Manitoba have been urging the formation of an interprovincial river board on the North Saskatchewan river. This action was prompted by the fact that effluents from industries near Edmonton were affecting the drinking water of communities downstream in Saskatchewan. The Alberta authorities and the industries concerned took action on complaints from the offended communities and the situation has been improved.

The International Joint Commission has continued to watch conditions in boundary waters and has made surveys particularly in the river areas such as the St. Mary's, St. Clair, Detroit, and Niagara Rivers, and has prepared standards and recommendations for the control of pollution in them. A report of the Commission's work published in 1951 sets forth general requirements, of a comprehensive nature, for the discharge of all wastes. They specify that wastes shall be in such condition when discharged into any stream that they will not create conditions in the boundary waters which will adversely affect the use of these waters for: domestic water supply, industrial water supply, navigation, fish and wild life, bathing, recreation, agriculture or other riparian activities.

Legislation by itself is not going to solve pollution problems. However, the right kind of legislation can help to create an environment in which intelligent, cooperative action is stimulated. Industry, in its own interest, should encourage suitable legislation. Over and above this, industry must in the construction and planning of new factories make adequate provision for cleaning up and disposing of wastes in ways which are acceptable to all local authorities and which leave the water in the streams below its plants in a form which can be reasonably used by others, for domestic or industrial use or recreation. In addition, industry should be examining all of its present operations to know exactly what wastes it is putting into streams. It should be examining carefully all the measures it might take to reduce these and it should be conducting research on ways of eliminating them.

The Transcona Grain Elevator

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can substantiate. Reasonable correlation, however, is gained using the other average cohesion values as shown in Table I. This is in spite of such factors as pumping that may have caused soil changes since the failure.

Difficult to explain is the length of time, 24 hours, which elapsed from the time motion began until the building came to rest. The plastic nature of the soils and the gradual transfer of load from the upper stiffer clays to the softer underlying material may be responsible. The slow failure and the varves in the brown clay do not appear to have invalidated the theoretical formula.

To the engineer, it is most reassuring that the study of the Transcona elevator failure and similar studies reported for the foundation failures on clays in widely separated areas, verify the present theories. The advantages of being able to predict the ultimate bearing capacity from a soil study are obvious. With the information now available and the additional studies being made on settlements, foundations on clay may be designed with reasonable knowledge of the safety factors involved and the future behaviour of the structure.

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Precipitation Over Southern Ontario

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speeds on the catch of the M.S.C. standard rain gauge.

Besides these, there is, of course, a great need for much more theoretical research on the factors affecting rainfall production and techniques for their maximization.

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Formal Graduate Study

A panel discussion held as Session 5 of the joint Conference of the American Society of Mechanical Engineers and the Engineering Institute of Canada, University of Western Ontario, October 1956

Newman A. Hall,
Professor of Mechanical Engineeiing, Yale University.
Moderator of the Session

It is a pleasure to be here this afternoon and join in a consideration of what has become one of the most pressing problems currently in the field of engineering education. Before introducing our panel, which will discuss this area of graduate training in engineering, I should like to provide a brief introduction.

In graduate studies in almost all fields of endeavour the growth of any area which is developing extensively as a profession has traditionally involved the introduction of graduate work in a purely academic manner at the most advanced levels and then after a long period of development pressures from the profession itself call for the development of advanced training which is of a much more professional nature than the purely academic type of work which is normally associated with the graduate schools. Engineering at the present time is in the midst of this transition where the practising profession is calling for more advanced training than has been traditional in our four-year undergraduate engineering curriculum so that it is becoming necessary for more and more professional training to be given at the graduate level. This advanced professional training is to be distinguished from the type of advanced work of a purely academic nature which represents the research endeavor to expand fundamentally the field of knowledge covered by engineering.

This pressure for expansion of our graduate studies in engineering is a recent development associated primarily with the tremendous technological advances which have come about during the past fifteen or twenty years and which were stimulated so very greatly by the close association of science and engineering during the past war. The circumstances which have existed recently have called upon the introduction into engineering practice many diverse areas of fundamental scientific knowledge which were formerly the province of the physicist and mathematician but which now must be put into practice by the engineer. Many examples of this growth of the area of engineering design and engineering practice could be given. These are all of such a nature that the man who is going to develop new design methods and new procedures in engineering practice will require familiarity with areas which can no longer be covered at an undergraduate level. The industries which depend upon engineers who are so trained are the ones which are providing the motivation for the expansion of our graduate activities.

We thus see a pattern developing where superimposed on top of the research or academic type of graduate study in engineering there is developing a need for training at an advanced level which leads directly to the professional advancement of the engineer. In many cases this advanced training is being given within industry itself and some of these cases will be referred to this afternoon. However, the staff resources of industry are frequently not sufficient to meet this need so that the universities are being called upon to provide all types of training activities within the academic framework which lead to this professional advancement. The growth of graduate studies in engineering, particularly at the Master's level, during the past ten years has been very substantial. Much of this growth can be attributed directly to this increased emphasis on professional advancement. At the same time, however, the growth of more research or academic type of graduate study should not be overlooked and there is much development in this field since the engineer in practice is calling upon the research engineer to provide him with tools in the application of new developments in science which have not been available in the past.

It is our objective this afternoon to give consideration to some of the aspects of these developments and to try to see more clearly the implication of the patterns of graduate training in engineering which are developing. We have four gentlemen with us who are thoroughly familiar with the developments of this problem each of whom will be able to present to you their own analysis of certain phases of the picture with which they are intimately familiar.

D. S. Simmons,
General Manager, Manufacturing, Imperial Oil Limited.

Being a member of the last panel in a symposium much as this gives one the advantage of hearing the viewpoints expressed in the previous presentations and discussions. In view of these discussions there are two additional questions I would like to hear discussed by those present. The first one is directed primarily to the educators and the second primarily to the industrialists.

My first point concerns the business which all of the educators present are occupied with, that is the production of engineers. In this field there seems to be considerable difficulty with semantics. There appears to be general agreement that producing an engineer today requires a considerable "broadening of the base", which I believe means a deeper understanding of the basic engineering sciences. At the same time it appears that the "specialization" will, of necessity, have to be reduced; in fact there is considerable discussion as to the merits of its complete elimination. It seems to me that the usage of these general terms is rather confusing and the business of producing an engineer is really rather simple. I suggest that this process can be divided into two phases. The first phase consists of teaching the prospective engineer the basic sciences necessary for the branch in which he intends to practice. The second phase of his education consists of acquiring the skill to take these basic sciences and apply them to a practical problem and arrive at an economic solution. If we can assume that this is the process involved in the production of engineers, then the question I pose is: Which of these two phases is the harder to teach?

In my twenty years of engineering practice I am quite convinced that most of the engineering failures are in the phase-two area. It has been my personal experience that this phase is the more difficult of the two to teach. If this is called specialization, then I heartily disagree that it should be eliminated and I might even object to it being reduced.

I believe every practising engineer has had contact with persons who are very well informed, even accomplished, in a very broad range of the natural sciences but these same people cannot, in any sense, be classed as engineers. On the other hand, I have known a few men who have Doctor's degrees in natural sciences who have been outstanding engineers. The phase two part of their education is something they were either given as a gift at birth, or something which their special talents permitted them to learn without formal education. It would seem that "specialization" or phase two is the very reason engineering schools were created.

Since we are discussing post-graduate education it would appear essential, from my view, that the course should include both phase one and phase two subjects and not be considered as the time for "specialization".

My second point concerns the discussions on the "shortage" of engineers. It appears that one of the major reasons for this shortage is the large number of engineers doing "non-engineering" work. Various ways of getting these engineers back to "productive" work have been considered. In looking at my own company, and I suspect it is true of a great many other companies, if we took all the engineers out of management positions and put them at engineering work we would have a surplus of engineers. No one to date has seriously suggested we do this as we are quite anxious to keep the business operating. If we consider the number of engineers in industrial management, we are forced to the conclusion that the largest (and most successful) management schools in the country are the engineering schools. Is this not the primary aim of the schools of business and commerce? When we are having discussions regarding the proper content of the curricula for an engineering school we strike, frequently, very wide differences of opinion as to which course will produce the best engineer. In view of the high percentage who become management I feel that many of these differences are insignificant. When the business schools are discussing the best curricula I presume it is just as controversial as our own discussions. I wonder if the business or commerce schools have observed the high percentage of engineers in management and take this into account when debating their curricula? I believe that engineering schools will continue to produce a high percentage of future industrial management and the business of producing management people is an obscure and elusive process. Wherever they go the engineering school can serve industry best by continuing to produce sound and competent engineers. The questions I would like to hear the industrialists present discuss are, first, whether or not they subscribe to these views on the making of management people and, secondly, do they view with alarm the number of engineers who are doing "non-engineering" work?

Warren C. Stoker,
Director of the Hartford Graduate Center,
Rensselaer Polytechnic Institute

The Hartford Graduate Center, a branch of Rensselaer Polytechnic Institute, Troy, New York, was brought into being to provide graduate education in science and engineering in an area lacking such a facility, but having a large number of working engineers.

The single largest industry in the Hartford, Connecticut, region is the Pratt & Whitney Aircraft Division, United Aircraft Corporation, which employs over 5,000 technical personnel. It is one of the leading developers and suppliers of jet engines. The United Aircraft Corporation recognized that its future was very much dependent upon its engineering staff. It felt that graduate education for its engineers was a vital necessity to the future well-being of the corporation.

Since the United Aircraft Corporation was confronted already with a shortage of engineers, the problem was one of making available degree programs at the graduate level on a part time late afternoon-evening schedule so that the engineer pursuing a graduate study program could remain a productive engineer. The UAC recognized also the necessity of an educational facility close to the industrial community so that travel time would not consume an undue amount of the engineer's free time. Rensselaer Polytechnic Institute along with several other schools of engineering in the East, was approached by UAC and asked to submit its proposal for meeting the above objectives.

The proposal made by RPI was selected; and so the Hartford Graduate Center of RPI was conceived in the late spring of 1955. In brief, the Rensselaer proposal called for the establishment of a branch of RPI in the Hartford, Connecticut, area. The branch would offer graduate degree programs in four major fields: namely, aeronautical engineering, mechanical engineering, mechanics, and applied mathematics. The graduate school would operate under the same rules and regulations and with the same standards of admission and course instruction as the graduate school on the main campus. The Hartford Graduate Center would be open to all qualified students (not those of UAC alone). The Graduate Center would have its own campus with a complete educational plant. The staff and faculty would be full time and resident. In other words this would be a true branch, not just an extension activity. Students in attendance at the branch would be in residence.

An existing modern building located in a suburban area convenient to any part of the Hartford area was purchased and converted into an educational plant comprising within its 22,000 square feet of floor space, large classrooms, two seminar rooms, one auditorium, cafeteria, library, and staff and faculty offices. There is parking space for 250 cars. The classrooms were provided with the necessary equipment including sound movie projectors, and desk calculators. The completed structure with all its equipment was given outright to RPI.

To assure that RPI would incur no financial loss in this undertaking, UAC agreed to underwrite the operational budget for a 5-year period

It further established a tuition assistance plan for its employees which permits an employee to obtain an advanced degree at no cost. Under the plan, the employee-student makes a $20 per credit hour deposit at registration. One-half of this amount is returned upon satisfactory completion of the course, the remainder of the deposit is returned upon completion of the degree program.

To ensure that graduate work at the new branch would be a continuance of that at the main campus, a nucleus of six full time professors was transferred from the Troy campus to the Hartford campus. Other full time professors were brought directly into Hartford. In addition to the full time faculty, some adjunct (part-time) professors were obtained from the industries in the Hartford area. These adjuncts, each an expert in his own field, all have advanced degrees, the majority holding a doctor's degree. The majority have had previous teaching experience. They are expected to attend faculty meetings, consult with students, and assist in the preparation of plans of study for students. To assure their willing participation in such activities, the adjunct professors are given a retainer fee, whether they teach or not. They are paid an additional amount for the teaching of a course. This arrangement has worked well. The adjunct professors are familiar with the educational objectives of RPI and contribute to the educational program of the Hartford Graduate Center. They have become well integrated into the faculty. The full time faculty are all now residents of the Hartford area, and devote their full time to the educational programs of the Center. The proportion of teaching adjuncts to full time professors has been such that for each class taught by an adjunct, there have been two taught by the full time faculty. The adjunct professors usually teach the courses of a more specialized nature.

The Hartford Graduate Center has its own library which is intended to provide for the educational needs of the students in the fields of major interest. Under the supervision of a full time librarian, the library currently holds 1,714 books, 210 bound volumes of serials, and 196 serial titles are currently received. In addition, the facilities of the RPI library at Troy are available as are those of public, college, and industrial libraries in the Central Connecticut area.

The Hartford Graduate Center is administered under the dean of faculty and the graduate division by a resident director. The director of the Hartford Graduate Center is also associate director of the graduate division. Non-academic matters are handled by the business manager. The functions of the office of admission, the registrar, and the controller are provided by these officials at the main campus.

There are no departments within the Hartford Graduate Center, nor do the various degree granting departments on the main campus have any administrative function relative to the Hartford Graduate Center. However, the programs in each major field offered at the Center are carefully coordinated with similar programs on the main campus through consultation between the faculties of the two campuses, through attendance at faculty meetings of the Graduate Center by faculty from the main campus and vice-versa, and through the use of a common catalogue and common set of course offerings. The graduate council is composed of representatives of the graduate degree granting departments on the main campus and representatives from the Hartford Graduate Center.

The schedule of classes has been arranged to permit a student to pursue a maximum of two courses per term, with involvement of not more than two evenings per week. The vast majority of the courses are three credit hours. Since a minimum of 30 cr. hr. are required for a Master's degree, a student may earn the Master's degree in a minimum of five semesters or 2 years, if he takes two courses each term. At the present time, the only degree awarded is that of Master of Science in a designated major field, e.g., M.S. in M.E. The classes are scheduled to be 1½ hours each and fall on either Monday and Wednesday or Tuesday and Thursday, there being no classes scheduled on Friday. The first class begins at 3:45 p.m., the second at 5:15, the third at 7:00, and the fourth at 8:30. The UAC permits its employees to leave work, without loss of pay, at 3:15 if they are scheduled for a 3:45 class.

Members of the panel. From left: W. C. Stoker; S. B. Ingram; Dr. M. Katz; D. S. Simmons; and Prof. Newman A. Hall, the moderator.

The first class entered in September 1955. It consisted of 215 students registered for slightly under 1,000 cr. hr. of instruction. Twenty-one different courses were offered. Five adjunct professors taught courses. During the first year the course offerings were expanded to include majors in Metallurgy and Management. Present registration comprises 350 students registered for 1600 cr. hr., in 31 sections involving 26 different courses. It is anticipated two additional majors will become available during the coming year, physics and electrical engineering.

Although the majority of the students were employees of the United Aircraft Corporation during the first term, there were a few students enrolled from other corporations from the outset. The number of corporations in the area participating in the plan has increased, and there are presently employees of 11 different corporations registered at the Hartford Graduate Center.

S. B. Ingram,
Director of Education and Training, Bell Telephone Laboratories, Inc.

It has been suggested by our chairman and by the other members of the panel that I give you a brief account of what we are doing at the Bell Telephone Laboratories through our Communications Development Training Program in continuing the education of our graduate engineers after they leave college and enter the employment of the company. What I say might perhaps be appropriately presented as a part of one of the earlier sessions under the heading of the Training and Orientation of the Graduate Engineer on the Job or of Amplifying the Baccalaureate Education, because what I am describing is an industrial training program not formal graduate study in a university. The excuse for bringing it in here is that although it is an industrial training program, it is unique in its extent and in the fundamental character of the formal course work which we are giving to these college graduate members of our technical staff.

I presented a rather complete paper of this same subject before the American Institute of Electrical Engineers in Chicago about a year ago. Anyone interested in more detail than I can present in the few minutes available here may wish to refer to that paper which appeared in the February 1956 issue of *Electrical Engineering.*

First I should say a few words about the Bell Telephone Laboratories to tell you what kind of an organization we are. We are the research and development unit of the Bell System and are concerned solely with work of a research and development nature in the field of communications and electronics. We are a large and mature organization. Our company goes back in its present corporate form to 1925 but since in its formation we took over the functions and personnel of our predecessor, the engineering department of the Western Electric Company, in effect we can trace our origin back to the turn of the century. We have about 10,000 employees, of whom about 3000 are on the professional technical staff.

The C.D.T. Program

The new college recruits at either the bachelor's or master's level enter the communications development training program, which occupies their entire time for their first year with the company and part of their time for the following two years. In this program our objectives primarily are long range. We are keenly aware that these young graduates are the new blood of our technical organization. As such, it is their ultimate potentialities for development rather than their immediate productivity which really counts most. We are concerned with providing these new technical staff members with engineering training of a fundamental nature which will equip them to attack the complex problems of the future by the most effective analytical methods available. We know that in the dynamic technology of the mid-20th century no training today can equip an engineer to solve the problems of tomorrow. If he is to function most effectively, his education and development will have to be a continuing process and he himself will have to be responsible for keeping his technical capabilities abreast of the technical arts of the future. We are concerned, therefore, with laying an educational foundation on which a sound structure of continuing technical self-development can be built. We believe that the best foundation for such continuing self-development consists of an education in depth and the attainment of technical maturity and not the mastery of numerous specific skills. All of these considerations have led us to the development of a curriculum much more fundamental in content than one might, at first glance, expect to find in an industrial training program.

For the first year, the entire time of the new man is devoted to the program. Classroom work consists of lectures and opportunities for recitation on three days of each week The remaining two days are spent or rotational assignments in the technica departments. In the second and thir years, classroom work is reduced t one day per week, and the studen having completed his rotational assignments enters his technical depart ment and is integrated into one of it regular projects.

The first-year courses are funda mental in nature, and all student pursue the same courses of study, a listed in Table I.

In those instances where a studer has considerable advanced trainin credit is sometimes granted fc courses in which he already is we prepared. Such a student takes a r duced program or, with others lil himself, studies advanced topics ou side of the regular curriculum.

In addition to the orientation cour described below, there are thr groups of courses dealing with tl fundamental disciplines of mathem tics, physics, and communication The mathematics group deals wi

Table I. Communications Development Training Program
First Year Curriculum

	First Term	Second Term	Third Term
Mathematics	Analysis I	Analysis II	Fundamental Circu Theorv
Physics	Physics of Waves	Atomic Physics	Solid State Physics
Communications	Probability and Statistics	Logic and Switching	Communication Theory
Orientation	Bell System I	Bell System II	Bell System III

Table II. Communications Development Training Program
Second and Third Year Curriculum
Group A. Required Advanced Courses

Number	Title
A2	Fundamentals of Technical Writing
A3	Semiconductor Devices
A4	Electron Tubes
A5	Electronic Circuits

Table III. Communications Development Training Program, Second and Third Ye Curriculum. Group B. Engineering Fundamentals Courses

Number	Title
B1-I	Microwaves
B1-II	Microwaves
B2	Passive networks and components
B3	Modulation theory
B4	Unifunctional switching circuit design
B5	Acoustics
B6	Probability Applied to traffic Engineering
B7	Design of experiments
B8	Communications engineering materials
B10	Human engineering
B11	Design for production and service
B12	Advanced mechanics and dynamics

Table IV. Communications Development Training Program Second and Third Year Curriculum Group C. Courses for Specific Areas of Work

Number	Title
C1	Transmission Systems Design
C2	Servomechanisms
C3	Multifunctional Switching Circuits and Systems
C4	Systems Engineering
C5	Radar
C6	Computers
C7	Principles of Mechanism Design
C8	Design Principles of Electroacoustic Apparatus
C9	Design of Relays and Electromagnets

topics of particular importance in the communications field, functions of a complex variable, the LaPlace transform, Fourier analysis, linear vector spaces, and the analytic aspects of linear circuit theory. The physics group contains a course in the physics of waves, inasmuch as wave motion is the basis of all communications phenomena; atomic physics, which is often not included in undergraduate engineering curricula; and the physics of solids, a subject of great importance now that the transistor and related semiconductor devices promise to revolutionize the entire technology of communications during the engineering careers of these young men. The communications group starts with a course in probability and statistics, in which the emphasis is placed on the interpretation and significance of laboratory data. It is followed by courses on logic and switching, largely the mathematics of digital systems; and communication theory, including the concepts of information theory.

The orientation course, called the Bell System, runs throughout the year. It devotes approximately one third of the time to orienting the student in the training program and in the Bell Laboratories, introducing him to the interrelations of the various parts of the Bell System, and giving an introductory treatment of engineering economy and of public utility economics and rate making. The remaining two thirds is devoted to a study of the various transmission and switching systems and of the outside plant which constitute the existing facilities of the company.

The second- and third-year curriculum is more specialized and is largely elective. The program of courses which a student takes is determined by his department and depends upon the needs of the department as well as on the interests and aptitudes of the individual concerned. There are three groups of courses, A, B, and C, shown in Tables II, III, and IV, respectively.

Group A consists of three courses in electronic devices and circuits and a course in technical writing. These are required of all students, because electronics is basic to modern communications, and experiences has shown that almost all engineering graduates can profit by further training in writing and that many need it badly.

Group B, a series of 12 courses on what we consider to constitute the engineering fundamentals of modern communications, leads up to group C, which deals in a rather specific way with various fields of Laboratories work in both the telephone and military areas. Even in the group C courses the attempt is to deal with the principles and the methodology of design and engineering rather than to catalogue the information of the various fields.

During the last several years we have put into the program a group of trainees ranging from about 100 to 150 in number. The total course program taken by each student comprises the equivalent of about 60 semester hours of course work as it would be measured in a university. What we are doing is therefore an educational effort of considerable magnitude.

Administration of the Program

The responsibility for the planning and presentation of the courses is vested in appropriate technical departments of the laboratories in order to keep the curriculum abreast of the most recent advances in the various fields. The research departments contribute heavily to the fundamental disciplines of the first year. The development departments assume responsibility for courses of a more specific engineering nature. In recent years, arrangements have been made with neighboring graduate schools to have certain of the more fundamental courses presented by members of their faculties. This has been done as a part of our program, on our premises, and close coordination with our technical departments has been carefully maintained. We feel that this cooperation between industry and education has added strength to our program, and hope that it has been of benefit also to the institutions and to their faculties. We are desirous of extending it in the future.

Little has been said so far about the rotational work assignments which take place during the first year, although they are a most important part of the program. They are designed to broaden the new member and to increase his potential usefulness to the organization. There are assignments to three departments which have been chosen because they offer technical experience of widely diverse types and because of the relation of their work to that of the man's technical department. In each of these temporary assignments a new member works at a regular and productive job which is a part of the department's regular program. This is in no sense "made work", although prime concern is that the new member learn, rather than that he produce. Care is maintained to see that the grade of work given to the trainee is of professional level. It is intended that in this part of the training program the student encounter in practice the many interrelations of his department with others, and that he learn something of the philosophy of the departments with which he will cooperate in his future work. Moreover, the opportunity to work closely with men in these related departments is of great advantage to a new member. In this way, he becomes acquainted with them, and when he needs advice or assistance in the future, he will know where to go for it.

Graduate Study Plan

Apart from the C.D.T. program which does not lead to an academic degree, the company encourages graduate study on the part of its staff members through a graduate study plan. Under this plan full tuition is refunded to employees who successfully pursue graduate courses in fields broadly related to their work in the company whether as a part of a program leading to an advanced degree or not. Under the plan time may be taken off during regular working hours up to a maximum of 7 hours per week without loss of salary if required for travel or for attendance at daytime courses not available outside of working hours.

In these days of engineering manpower shortage these educational programs are difficult to maintain. They divert a substantial amount of engineering effort from the many pressing and immediate problems which face us. We would not be devoting this effort to them if we did not feel that they were essential in the solution of the greatest problem of all, the building and maintenance of a research and development staff of the highest order of competence. There are doubtless many other ways to approach the problem, we have chosen this one. All of the ways will have one thing in common. They will aid and foster the continuance by the engineer of his education on the graduate level after entering industry.

Dr. Morris Katz,

Occupational Health Division,
Dept. of Health and Welfare, Ottawa.

Canada's rapidly expanding industrial economy in the postwar period and the demands of national defence and other federally-sponsored activities have combined to create a critical shortage of technical and scientific manpower. There is no doubt that this shortage will become more acute before effective remedial measures can be brought into play. A solution of this problem requires the serious attention of industrial leaders, university educationists, engineers and scientists, professional societies and responsible leaders of government. The universities are faced with a lack of class rooms, laboratory and equipment facilities to handle any sudden large increase in student enrollment. It is also of vital importance to increase greatly the teaching staff at existing universities and to provide for teachers and professors from the ranks of graduate and postgraduate students to staff the new buildings and universities which will be needed in the near future.

In some respects the key to the problem of overcoming the shortage of engineers in the future lies in the expansion of financial assistance to both undergraduate and graduate students to ensure that no worthy student is prevented from continuing his university training because of lack of funds alone. In his brief to the recent National Conference of Engineering, Scientific, and Technical Manpower, at St. Andrews, N.B., S. H. Deeks, of Orenda Engines Ltd., indicated that there is an immediate need of 3,700 more university teachers in Canada, or about 60 per cent more than the present staff. Over 20 per cent of the university graduates will be required for the teaching profession. At present there are about 40,000 engineers in Canada, but this force will have to be increased from three to four times within the next twenty-five years if this country is to maintain its competetive position with respect to other progressive industrial nations.

University Enrollment and Immigration of Engineers

To illustrate the role of the engineer in our industrial economy, the number of production workers per engineer in Ontario has decreased from 368 in 1945 to 145 in 1955, whereas in the United States one engineer is required for every 75 production workers. In the postwar period the shortage of engineers has been alleviated to a certain extent by the immigration of engineers into Canada from the United Kingdom and other countries. The extent of this type of immigration within recent years is shown in Table I. On the average, about 280 Canadian engineers have emigrated to the United States annually over the past three years.

Table I
Immigration of Engineers into Canada[2]

	1953	1954	1955 (9 ms. only)
United Kingdom	754	1,003	1,061
United States	168	130	120
Other countries	393	454	532
	1,315	1,687	1,713

The extent of engineering enrollment and corresponding degrees conferred at the undergraduate and graduate levels in universities and colleges of Canada and the United States in 1953 and 1954 is indicated in Table II. It has been predicted by Dr. O. M. Solandt, vice-president, Canadian National Railways, that Canada will require an average of 6,000 engineering graduates each year over the next 25 years, or more than four times as many as are graduated from Canadian universities at the present time.

The post-graduate training of engineers in formal graduate studies is just as vitally important as other training aspects in the continuing education of the engineer. Canada lags far behind the United States in the proportion of graduate to undergraduate engineering enrollments, as shown in the data in Table II. Whereas in the United States the number of engineers enrolled in graduate schools for advanced study in 1953 and 1954 represented 12.6 and 10.7 per cent, respectively, of undergraduate enrollments, the corresponding percentages in Canada were only 3.5 and 3.1. One of the reasons for this disparity is the lack of adequate resources and facilities for advanced study in engineering in faculties of Canadian Universities. About 1,600 graduate students in all branches of science, including engineering, attended Canadian universities in 1955. At the same time, about 800 Canadian students were engaged in graduate studies in the above fields in the United States. A smaller number was registered at post-graduate schools in the United Kingdom and other countries.

In the United States about 50 to 57 per cent of all engineering students engaged in studies towards a master's or other pre-doctoral degree in the years 1952-1954 were taking evening courses. Over the same period evening students working for doctorates in engineering comprised a proportion amounting to approximately 23 to 24 per cent of all doctorate students. No comparable evening courses are available to Canadian students.

Graduate Study in Engineering

Our industrial effort and its dependence on science and technolog for continued growth have reache the stage where the need for grad uate education is well recognized The four or five-year baccalaureat programme is insufficient to provid the necessary scientific foundatio and training for those engineers qual ified to undertake creative work i design and research. Both industr and the teaching profession requir that an increasing proportion of en gineers should have the benefit of more profound knowledge of th basic sciences and mathematics, a well as more understanding of th humanities and social sciences.

The concepts, objectives and r quirements of a graduate study pr gramme have been discussed tho oughly by various American commi tees, such as those of the America Society for Engineering Educatio and the Engineers' Council for Pr fessional Development[5]. It is reco nized that graduate study should re resent a considerable advance i subject matter and attitudes beyon the undergraduate phase. Broa training in new concepts of scientif analysis, synthesis or design is r quired to cope with the increasi rate of development of new indu tries, structures, products or oper tions.

Procedures to Encourage Graduate Study.

At the present, only about one tenth of engineering graduates in Canada eventually acquire graduate degrees. This proportion is about twice as high in the United States. Much more extensive efforts on the part of industry, the universities, and government will be required to remedy this situation, even though it is recognized that graduate study in engineering has become an almost indispensable asset for those who are required to engage in process and plant development, design and research.

It is a well-known fact that a great many Canadian companies are branch plants or associated with United States industries, consequently most of the industrial research and design for such companies are carried on elsewhere. However, there is an increasing tendency for such branch plants and purely Canadian industries to undertake research and design for themselves. Government - sponsored research by Crown companies and other organizations such as the National Research Council, the Defence Research Board, Atomic Energy of Canada, Limited, and Polymer Corporation has been extremely successful, and has attained a high level of recognition all over the world.

Procedures to encourage graduate study involve a three-way effort of cooperation and distribution of responsibility between employers in industry or government, the universities and students. These include the following types of programmes involving financial assistance on the part of industry and government.

(1.) Bursaries and studentships for full-time graduate study.
(2.) Fellowships.
(3.) Assisted part-time or evening courses.
(4.) Grants-in-aid to universities or faculty members.
(5.) Sponsored research programmes.

In the United States, in large metropolitan centres, a considerable number of graduate engineering students attend part-time late afternoon or evening classes for higher degrees while employed professionally. Although such students are usually more mature, they run the risk of being overworked and obviously require a much longer period to complete degree requirements. It is far better to provide sufficient financial assistance to enable qualified students to undertake full-time graduate training.

Specific Plans

Large Industries. Some interesting facts on the procedures and policy of a number of large-scale employers of engineers in Canada for encouraging such staff to undertake advanced degree studies and for sponsoring such programmes financially were obtained from replies to a questionnaire. One large company, employing about 1,000 graduates, has provided assistance for many years to graduates in general through its part-time employment and fellowship programmes, although it does not provide to employees direct financial assistance for postgraduate study. At the present time, about twenty per cent of its graduate employees hold two or more university degrees. This number is considered sufficient to meet its present requirements for advanced technical competance and the present emphasis is upon management training programmes. Enrollment in such administrative courses conducted by universities and professional societies is encouraged and fully supported financially.

Table II. Engineering Enrollment and Degrees Conferred[3]

	Undergraduate		Graduate		
	Enrollment	First Degree	Enrollment	Master's or Pre-Doctoral Degrees	Doctor's Degrees
Year	1953	1952-1953	1953	1952-53	1952-53
Canada	6,662	1,168	232	87	18
United States	171,725	24,164	21,608	3,743	592
Year	1954	1953-1954	1954	1953-54	1953-54
Canada	7,529	1,036	235	90	23
United States	193,692	22,236	20,722	4,177	590

A large smelting company indicatet that, although it had no formal plan covering engineers who wish to return to the university for postgraduate work, various arrangements are made, depending upon the circumstances, after consideration of each case on its merits. Leave of absence is granted to engineers who obtain scholarships or to those returning to the university for advanced degrees. In such cases the individuals continue to be covered for employment welfare benefits and their service is protected for pension purposes. In certain cases, an engineer may be placed on a retainer fee while on unpaid leave of absence to obtain his advanced degree.

Other companies grant leave of absence without remuneration to engineers who wish to undertake formal graduate study but attempt to provide suitable summer employment.

The management of Aluminum Company of Canada, Limited, has for some years operated a post-graduate school, connected with the University of Geneva, at Geneva, Switzerland. The associated company, Aluminum Laboratories Limited, has established a graduate fellowship at McGill University and at the University of Toronto, with preference being given to individuals proceeding to the Ph.D. degree in physical metallurgy or related subjects. These fellowships have a value of close to $3,000 per annum.

The International Nickel Company of Canada, Limited, has announced recently a comprehensive programme of educational grants totalling $2,-500,000, over a five-year period, to assist a large number of institutions of learning in Canada's ten provinces. Of the above sum, approximately $500,000 will be allocated for scholarships, fellowships and special projects, including assistance to teachers of science and mathematics. The Company's present fellowship programme for post-graduate studies will be increased to establish one fellowship in each of Canada's thirteen major universities. These fellowships will have a tenure of three years and provide an annual stipend of $1,500 plus tuition fees, and will include also an additional annual grant of $500 to the institution.

The Imperial Oil Company graduate research fellowships were first introduced in 1946. This plan is open to graduates of any recognized Canadian University for post-graduate study leading to the doctorate, and the fellowships may be held up to three years. Employees that can meet the conditions of the awards are also eligible. Five awards, each of which has a maximum value of $2,000 per annum, are offered for competition every year in the fields of Engineering, Physics and Chemistry.

Government and Affiliated Departments

The National Research Council of Canada

Although the funds expended per capita by Canadian industry on research is much lower than that in the United States, the government per capita spending on research in Canada is probably just as high. It is well known that the National Research Council has had a fundamental influence on the growth of post-graduate research in scientific fields in Canada since its modest beginning in 1917. In addition to the high quality work that is being carried out in various divisions of N.R.C. at its Ottawa and regional laboratories in the fields of applied and pure science in chemistry, physics, biology and various branches of engineering the Council operates an extremely large awards programme consisting of grants and scholarships. Annual grants are made to professors to assist in the promotion of scientific research at the universities. These funds provide for student and other assistants who may be hired by professors, supervising approved research projects, and for the purchase or construction of specialized research equipment not normally available at universities. Scholarships are made available to post-graduate students with the required qualifications for study at Canadian Universities, for Canadians to study abroad, and for foreign students to come to work in Canadian government laboratories. The awards are made on an impartial basis, solely for merit, on recommendations of the Scholarships Committee of the Honorary Advisory Council. The growth of the above programme over the years is shown in Table III.

Within recent years the National Research Council has maintained an overseas post-doctorate fellowship programme which has attracted to Canada considerable numbers of scientists from the United Kingdom for research work at N.R.C. Laboratories and at universities. In addition, the N. R. C. administers consolidated grants for nuclear research and equipment for the Atomic Energy Control Board. The percentage distribution of all N.R.C. scholarships by fields of research, as shown in Table IV, is highest in chemistry and physics. Engineering (including chemical engineering), mathematics, geology and mineralogy account for 21.2 per cent of N.R.C. scholarships awarded for graduate studies as of March, 1956.

Post-doctorate overseas fellowships which are granted to graduates who already have a doctor's degree have a value of $2,500 per annum. Special scholarships for those who are given the opportunity for various reasons to study for advanced degrees outside Canada have a value of $2,000 per annum. Student scholarships for those who are proceeding to take the doctor's degree in Canada are worth $1,200 per annum and bursaries for students in the first year after gaining the bachelor's degree yield $800 per annum.

Table III. National Research Council Awards

Year	Scholarships	Grants-in-Aid	Totals
1919-20	$20,100	$33,316	$53,416
1929-30	49,990	220,442	270,432
1939-40	31,562	337,997	369,559
1949-50	210,670	1,342,106	1,552,776
1955-56	768,249	1,718,720	2,486,969
Totals for period 1917-1956	4,241,675	17,684,148	21,925,823

Table IV. Percentage Distribution of 269 N.R.C. Scholarships by Field of Research, March, 1956

Field of Research	Per cent distribution
Chemistry	25.5
Physics	24.1
Biology and biochemistry	18.6
Engineering (including chemical engineering)	9.3
Mathematics	8.6
Geology and Mineralogy	3.3
Other fields	10.6
	100.0

Civil Service Commission

Employees of federal government departments subject to the rules and regulations of the Civil Service Commission may be eligible for educational leave with pay under specified circumstances as follows.

(1) An employee who is directed to carry out a research project at a university, because of special facilities there, or to do any departmental work at a university, may be permitted to seek academic credit for further studies while at the university.

(2) Educational leave may be granted where it has not been found possible to obtain a qualified person for a specialized position.

(3) Refresher courses or courses of special instruction at a university are open to selected employees of a department, under certain special conditions;

(4) Leave without pay for attendance at university to selected employees, with approval of the Commission, may be granted after at least one year's continuous service, to assist the employee in increasing his efficiency and gaining advancement in the service.

(5) In the case of a university graduate who desires to pursue a planned course of post graduate study, the requirement of one year's continuous service may be waived, if such action is considered by the Commission to be in the public interest.

The Athlone Fellowship Scheme

The background and details of this scheme, which is designed to bring to Great Britain every year thirty-eight Canadian graduates in engineering for post-graduate studies, have been described by Dr. W. Abbott.[9] These Fellowships have a duration of two years and are tenable in industry, in universities, or partly in each of these. The plan has been in full operation since 1951 and the net cost is carried by the British Government. Financial assistance to holders of Fellowships covers the following items: *(a)* the costs of travel from the applicant's home to his place of training, of travel within the United Kingdom as may be approved, and of the return journey; *(b)* a subsistence allowance of £6 10s. 0d. per week, net; *(c)* the cost of tuition at a university; *(d)* an allowance towards textbooks; *(e)* a travel grant of £25 per annum for journeys within the United Kingdom. Industrial employers are asked to pay into a central fund the wages they would normally pay to a trainee of the college apprentice type.

Before the inception of the above scheme, it was well known that although considerable numbers of engineering graduates have come for further training to the United Kingdom from Australia, New Zealand and South Africa, relatively few have come from Canada, mainly because Canadian graduates have available to them the nearby educational resourc

(Continued on page 1087)

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

ROLE OF THE EARTH SATELLITE IN FOUR IMPORTANT IGY EXPERIMENTS

R. W. Porter—*Aeronautical Engineering Review,* May 1957, v. 16 no. 5

Four experiments which can be accomplished using a small earth-circling, instrumented satellite have been selected as having top priority in the current International Geophysical Year satellite program. The satellite will be a highly polished, silvery, spherical body of about 21 lb. and 20 in. diameter. It will contain a radio transmitter operating up to several weeks in the 108-mc. range with a power level somewhere between 10 and 100 milliwatts. This radiation will permit radio tracking. During short periods the power provided by chemical batteries can be increased to permit transmission of data to the ground. If the rocket launching goes as planned the orbit of the satellite will lie entirely above 200 miles altitude but may extend out as far as 1500 miles. At 200 miles it should be barely visible to the naked eye if in the neighbourhood of the observer, within about an hour after sunset or before sunrise. With ordinary binoculars the sphere should be easily visible.

One experiment to be performed is to measure the ultra-violet radiation from the sun at approximately 1216 angstroms. This wavelength is emitted by hydrogen and represents a large part of the total ultraviolet radiation received from the sun. The equipment consists of a tiny ionization chamber filled with nitric oxide gas. This gas begins to ionize at about 1340 angstroms. A lithium fluoride window used in this cell will not transmit wavelengths shorter than 1100 angstroms. Therefore the cell responds only to the narrow band of ultraviolet. Simple electrical circuitry "remembers" the peak value from each orbit around the earth (90 minute trip) and transmits these data together with a short period of continuous observations via radio telemetry whenever the satellite passes over a receiving station.

Most of the energy which is absorbed in the upper atmosphere comes from solar ultraviolet and X-radiation. The absorbed energy appears first as ionization affecting long-distance, point-to-point radio transmission on the surface of the earth, and causing such phenomena as glow of the night sky. Eventually part of the energy penetrates to lower levels in a manner not completely understood and influences weather and climate.

A second experiment is to measure the earth's magnetic field. One part of this field which is constant or changes very slowly is associated with the solid body of the earth itself, and the other which changes rapidly is created by the motion of the electrical charges in the upper levels of the atmosphere at altitudes several times the earth's radius. The instrumentation needs to be extremely precise to determine variations which are relatively small. A proton precession magnetometer will be used. Its operation depends upon the fact that protons have both angular momentum and magnetic moment. If a number of protons are aligned in the same direction by means of a powerful magnet and then released they will precess in the earth's magnetic field at a rate regulated only by the scalar value of that field. This rate will be measured by pickup coils and transmitted directly to the ground by radio telemetry. The data will be useful in analyzing magnetic "storms" which affect communications and aerial transportation, and in testing hypotheses which have been made about streams of charged particles in the upper atmosphere.

The third investigation concerns the nature and origin of the high speed particles known as cosmic rays. Measurements of their characteristics have been difficult because of their interaction with the atmosphere causing creation of secondary particles which obscure the effects it is desired to measure. A Geiger counter will be used to measure the total incidence of cosmic rays at levels well above the atmosphere, without respect to charge, energy or direction. A miniaturized magnetic tape recorder will be included so that data taken during the complete orbit can be played back in a few minutes while the satellite is within range of a receiving station. The practical significance of this cosmic ray information will not be known until later when it can be correlated with data from upper atmosphere "sounding" rocket tests.

The fourth experiment will measure the terrestrial energy balance which is the energy received from and given off by the earth to its environment. The principal energy input of the earth is directional from the sun. Some of the input radiation is diffusely reflected by clouds, the remainder is converted to heat and is ultimately re-radiated in the far infra-red portion of the spectrum. Four bolometers will be used fastened to the exterior of the satellite in a plane normal to its axis of spin. Three will be spherical, one coated black (emissive) at all wavelengths, one white (reflective) in the visible but almost black in the infra-red, and one with a special coating which is nearly black in the visible part of the spectrum but highly reflective in the far infrared. The fourth will have a special shape so that it will respond differently to the diffuse radiation from the earth than to directional radiation from the sun.

The four equilibrium temperatures obtained by the bolometers will be recorded on magnetic tape at approximately 180 points on each orbit and transmitted by radio telemetry when passing over a receiving station. Considering weather as a thermal engine which receives heat input from the sun and exhausts by radiation to space such fundamental data will be useful in predicting large scale movements of air masses.

Other secondary experiments will include pressurized chambers with pressure switches to give an indication of leakage rate in case of puncture by a meteorite, exposed resistance strips to measure surface erosion by micrometeorites and gas molecules, a microphone and counter to record the number of contacts with micrometeorites above a certain minimum energy level, and thermistors to measure skin and internal temperatures. Numerous other experiments which do not depend upon internal instrumentation will be carried out through observations by precision radio equipment and highly accurate photo-telescopes.

NEW POSSIBILITIES FOR PRODUCTION

G. R. Fitzgerald—*SAE Journal,* May 1957, vol. 65 no. 6

New production processes and techniques are being developed through research by the Process Development Section of General Motors. The article discusses some of the developments and may provide some indication as to what the future holds for production.

One of the most interesting fields is the saving of material in the cold extrusion of metal usually giving as well improved physical properties, reduced machining requirements, closer tolerance, and improved finishes. New metal-coating materials and processes show promise of future savings in material. In many cases where high-cost materials are required because of surface characteristics only, new coating processes permit the substitution of low-cost base materials. Resistance to corrosion, wear and heat often can be provided more adequately and more cheaply than through the use of alloys. Many coatings now available such as ceramics, carbides, molybdenum, and others being perfected will find numerous applications in this field. The direct conversion of steel machining chips into parts is another process which has improved to the point where it has great potential for the saving of material. Techniques have been created which make this a relatively simple process and the physical properties of the parts formed closely approach those made from mill-processed steel.

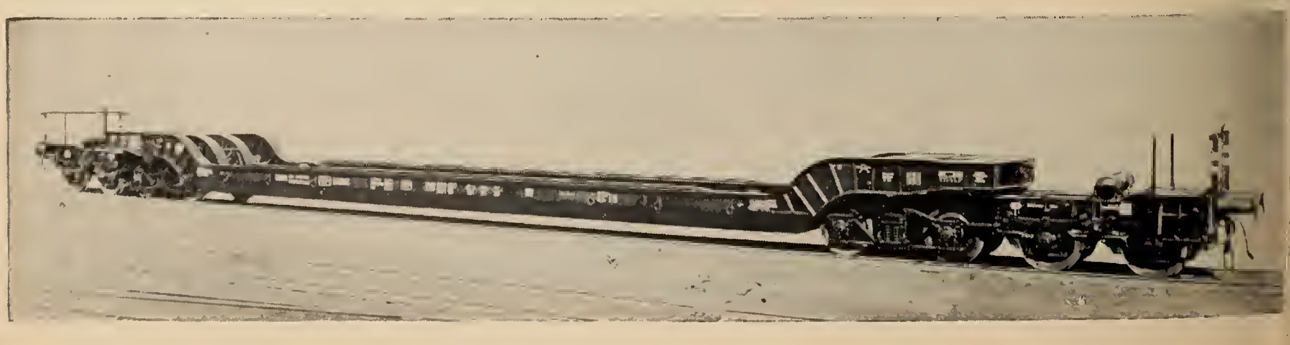
Another recent development is the use of metal adhesives. While they may not completely replace conventional joining processes such as brazing, soldering and welding, they should find wide application. Examples in the automobile industry are in the assembly of aluminum die cast parts and in the application of metal body trim.

The use of modern methods-engineering techniques and procedures greatly improves labour utilization and ensures that even the smallest increments of expended effort are productive. At General Motors the largest single group in the direct labour force is that employed on assembly work. This is an area that has been traditionally manual and i offers great potential for continua improvement through the applicatior of methods engineering and througl the development of mechanical assembly equipment. One GM divisioı has over 100 semi-automatic assembly machines in operation at the present time. The greatest limiting facto to the use of such equipment is economic, the machines being uniqu and therefore expensive, and requiring large run production. Machine in use are assembling such units a spark plugs and engine cylinde heads. Integration of machines an equipment with simple material handling devices provides continuou flow and this is being widely adopte where product uniformity permit The use of electronic computers i the control of production logistic also offers great opportunity for improvement in materials handling.

Developments in the fields of electronics have provided many new inspection tools which are making important contributions to improve quality of products. Use of automatic feedback control with continuou automatic gauging systems have improved the tolerances possible wit modern grinding machines. Gaugin circuits can now be developed whic will do the same for machines usin single point tools, and in addition t policing of size limits, will also indcate tool trends and in many case anticipate cutting tool failure prior t making of a faulty piece. Electroni equipment is being used in the mea

STANDARD GAUGE 16-WHEELED 103-TON WAGON

The loading frame is carried on two 8-wheeled bogies with roller bearing mounted on 940 mm. (3 ft. 1-1/64 in.) dia. wheel Each bogie is composed of a frame carrying two sets of wheels and a 4-wheeled unbraked Diamond bogie. The well-type loading frame is of all-welded St 5 steel construction. Each bogie is fitted with separate draw-and-buffer gear. Two 10 in. air brak systems one for each braked bogie with slack adjuster and brake timing control are provided. In addition, the wagon equipped with two hand-operated screw brakes. The wagon is designed to permit lateral movement of the loading fram facilitate transportation of oversized loads. (Photos: Fried. Krupp/German Industries Fair, Hanover.)



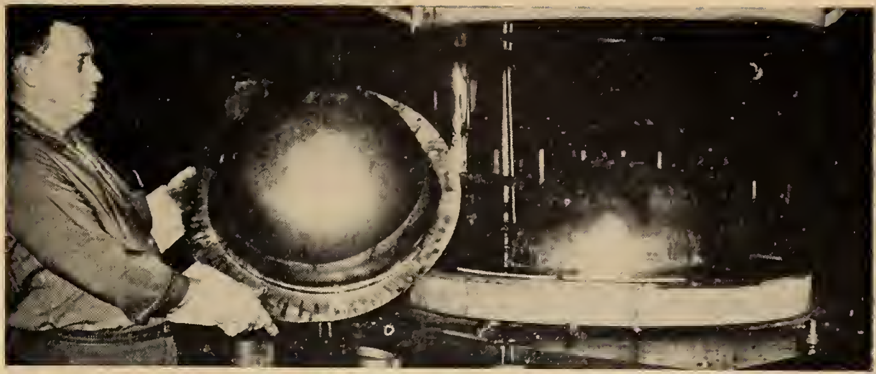
urement of vibration or noise in such items as ball bearings, gear trains and electric motors and in addition to making possible the setting of accurate standards it permits measurement in total and in individual frequency ranges, some of which can not be detected by the human ear. The photocell and phototransistor have relieved the human eye of fatiguing tasks in inspecting ground or polished surfaces for tiny flows. By measuring the change in light reflection between a fault and the desired surface precisely, blemishes barely perceptible to the human eye can be detected with unbelievable rapidity.

Ultrasonics, magnetic and radioactive techniques are now being used to check characteristics which heretofore have been determinable only by destructive means. Ultrasonic instruments which have been commonly applied in the detection of flaws in large steel blocks that are impenetrable by the largest X-ray equipment, are now being successfully used in checking weld quality.

Another electronics application which will be of increasing interest to production engineers is that of static machine controls. One of the most serious problems with modern automatic equipment is the trouble shooting and maintenance of electrical control circuits. Limit switches and relays cannot be expected to last indefinitely nor can the faulty ones always be quickly found and easily replaced. Recently developed static-control systems which eliminate a large percentage of the moving parts of an electrical control system will contribute effectively to improvement in this area. Test comparison of such a system with a normal type resulted in only two operational failures in 9 million cycles for the static or mag-amp circuit while replacement of relays in the standard control was necessary after 3 million cycles.

At present the static control system is more expensive but costs should be reduced as volume increases and as manufacturers gain experience.

Expensive and time-consuming tooling operations caused by design and style changes will receive considerable attention in the future. Development work is going on in "cookie-cutter" type of dies for sheet metal blanking and piercing. Plastic dies for drawing and forming are being considered. Dies made by these techniques are generally one-tenth the cost of conventional types. Although their life is much shorter, improved materials and greater knowledge of their use will prove them to be adequate for many applications.



MANUFACTURING THE IGY EARTH SATELLITE

The spheres for the earth satellite to be launched during the International Geophysical Year are made from 0.091-in. magnesium alloy by deep-drawing from a 32-in. dia. sheet blank, using a graphite lubricant, followed by hot-spinning (at 600°-650°F.) to make an exact hemisphere. The finished hemisphere is machined to a skin thickness of 0.028-in. The outside surface of the shells will have a coating of silicon monoxide, a very thin coating of aluminum (applied by vapour deposition) and a final coating of silicon monoxide. The coatings are to increase heat and light reflectivity. The expected temperature range the satellite will encounter is from about −200°F. to 450°-600°F. (Photos: Acheson Colloids Co.)

ALUMINUM PRODUCTION IN THE CAMEROONS

French Economic and Technical Bulletin, No. 9-10, 1956

Although France's 130,000-ton production of aluminum in 1955 is not enormous compared with the North American production of over two-million tons, it is a sizeable industry and will expand to meet French needs.

The cost of electricity in metropolitan France is too high for expansion of the industry there, but there are three major aluminum production projects being planned in French territory in Africa. Two projects, at Konkoure in Guinea and Kouilou in the Middle Congo, are in the study stage. The third, at Edea in the Cameroons, is under construction and is due to reach full output of 45,000 tons a year at end — 1958.

The Edea project is based on the Edea power plant, opened in 1954 to provide power for the port of Douala, 50 miles away, and now to be sextupled in capacity. This will make it the third largest hydro-electric plant in the French union, producing 1000-million kwh. The original 150 million kwh. will serve Douala, the additional power going to the aluminum plant. The plant will be arranged with a transformer substation feeding four parallel buildings, each some 2000 feet long and containing 52 vats. A special wharf and other facilities are also provided, together with housing and recreation areas for the employees.

Construction on the other two sites mentioned will begin when Edea is in full production. Konkoure, in Guinea, will produce 3000 million kwh., with a potential of 5000 million kwh., and has the added advantage of adjacent bauxite deposits. Kouilou has a potential of about 7000 million kwh.

BRITISH CONFERENCE ON AUTOMATION AND COMPUTATION

Process Control and Automation, vol. 4 no. 5

British industry has recently been interested about the need for a group to concern itself with automation in the widest sense of the word. A preliminary investigation showed that the requirement was for a coordination of the activities of existing organizations rather than the creation of a completely new body which might overlap those already established. Approaches were therefore made to the major Engineering Institutions although it was realized that many other interests would have to be represented. Not only the technological but also the sociological. As a result of the exploratory conference the following statement was issued:—

"Because of the rapid growth of the new industrial techniques popularly known as automation, which also comprise automation, process control and data processing generally, and of the many persons likely to be affected by their application, it became increasingly clear, towards the end of 1956, that there was an urgent need for the establishment of some central organism to afford liaison between all the interested organisations.

"It was realized that a very broadly based structure was desirable and at the invitation of The Institution of Civil Engineers, The Institution of Mechanical Engineers and The Institution of Electrical Engineers, Exploratory Conferences were held on 6th March and 16th April as a result of which the representatives of some twenty organisations with interests in the fields of automation and computation, approved proposals for closer collaboration, and agreed to recommend them to their Councils for adoption. The proposals, if accepted by the bodies concerned will result in the setting up of a British Conference on Automation and Computation which will be organised in three Groups of Societies having the following fields of interest:

Group A—The engineering applications of automation techniques.

Group B—The development and applications of computers, automatic controls and programming techniques.

Group C—The sociological and economic aspects of automation and computation procedures.

"The following bodies would be invited to act as the Convenors and Sponsors of the three Groups:

Group A—Convenor: Institution of Mechanical Engineers, Institution of Civil Engineers. Additional Sponsors: Institution of Chemical Engineers, Institution of Electrical Engineers, Institution of Production Engineers.

Group B—Convenor: Institution of Electrical Engineers. Additional Sponsors: Institute of Cost and Work Accountants, Institute of Physics, Office Management Association, Society of Instrument Technology.

Group C—Convenor: British Institute of Management. Additional Sponsors: Industrial Welfare Society, Institute of Cost and Works Accountants, Institute of Personnel Management, Institution of Production Engineers.

"An essential feature of the proposals is that liaison between the Groups should be established on a permanent basis from the outset, and it is foreseen that the central unit of the Conference which will be established for this purpose will undertake such other duties as, for example, the preparation of periodical digests of published papers falling within the general fields of automation and computation.

"If the proposals are approved by the several Societies the Convenors and Sponsors of each Group will summon further meetings. Any other body would be very welcome to apply for membership. At these conferences detailed arrangements will be settled for liaison within the United Kingdom so that progress in the fields of automation and computation and their applications can be fostered, and so that in the international field, the British contribution to international conferences can be focused.

"There was unanimous agreement that great advantage to the country would ensue from the measures of collaboration, it being fully recognized that, in the framework of automation, the importance of the human side is equal to, if not greater than, that of purely technological aspects."

It is hoped that this organisation will function as a vigorous and forward thinking body. The opportunities presented by automation must not be thwarted by outmoded policies and practices. Dead wood must be rigorously cut out to allow fresh and vigorous industrial growth. This conference can play a great part by assisting in this operation providing it is able to secure the goodwill of all parties concerned. Its widespread character allying the technological and human sides presents a unique opportunity for industrial achievement.

THE SHAPE OF LOCOMOTIVES TO COME

Engineering, 1957, v.183, no. 4755, 27 April.

This might have been the title of the obviously heartfelt plea of the writer of the column "Plain Words", who asks: "Why can't Diesel and electric locomotives be more like steam locomotives? Why can't they have manly lines and robust personalities?"

There is little evidence that the newer forms of railway traction are being given decent outward shapes. They are not allowed to show their functional parts, and components are clothed to the taste of the designer, so that there is no vital and positive idiom of design. Generations of men and boys have had an affection for the steam locomotive; its disappearance will lead to an inestimable loss of good-will towards the railways.

The writer speaks feelingly of current trends in design. "It is more than likely that the new locomotives will develop, in outward form, like the American motor-car — each successive design becoming more and more sensual and cheaply glamorous. The latest products of Detroit show all too plainly how readily an excitable designer could make a pair of locomotive buffers look like a certain vital statistic. This trend might impress an overworked railway officer but it would not affect the boys who are the next generation of passengers and railway officers. Unless, of course, we are misjudging the sophistication of modern youth."

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

Progress by NYSPA

Progress during May was highlighted by the completion of the Chimney Island channel improvement work five months ahead of schedule. Despite wet weather conditions which hampered excavation, construction progress on the project as a whole continued on schedule. Concrete placement for all features exceeded 1,100,000 cubic yards and excavation passed 39.5 million cubic yards. Employment averaged 4,860 for the month.

Concrete placement at the Barnhart Island power-house continued on schedule. Approximately 63,000 cubic yards were placed during the month bringing the total to date to 586,000 cubic yards. Concrete also was placed in the various switchyard structures and in the transmission line towers.

At Long Sault dam, approximately 130,000 cubic yards of common material were excavated from within the stage II foundation area, rock excavation was started and the downstream cofferdam was being brought up to grade. At Iroquois dam, 30,000 cubic yards of concrete were placed during the month, bringing the total to date to 138,000 cubic yards.

At Massena intake, work was continued on the upstream and downstream cofferdams. Material was being placed on the downstream cofferdam to reduce the seepage. The area within the cofferdam had been unwatered and preparations were underway for starting the foundation excavation.

Excavation work under two of the five channel improvement contracts was essentially completed. Work was continuing under the remaining three contracts. The channel work was approximately 70 per cent completed. Continued good progress was being made by the reservoir clearing contractors with 5,500 acres or half

The power-house takes shape.

of the clearing work completed.

Chemical treatment of the Barnhart-Plattsburgh transmission line continued. Materials for the line construction were being unloaded and hauled to the structure sites. Erection of structures was started in the Helena-Bombay area.

Work under the three highway relocation contracts was progressing ahead of schedule. The contract was awarded for the construction of Richards Landing dike.

Progress by Ontario Hydro

There were several rainy periods throughout the month of May. This delayed work in some sectors of the project, particularly dike building operations. The work force in May climbed to a total of 4,675 persons.

Erecting of structural steel for the generating station erection bay and administration building was started in May and had advanced well by month end. The steel erection for this building is expected to be completed in July.

Concrete placing at the power-house site progressed favourably throughout the month, bringing the total to 595,000 cubic yards. Concrete operations were completed for No. 12 draught tube and No. 1 ice sluice deck slab, and girder beams have been placed to full height. Progress also was being made with mechanical equipment installation, and speedring No. 7 and the pit liner had been assembled.

On Cornwall dike, work was resumed in all sections. Placing material on the main dike areas in sections No. 1 and 2, north and east of Mille Roches continued, but was hampered somewhat by wet weather. Material also was placed in the sector around the dike closure structure north of the power-house. Nearly half the material had been put into the power-house section of the dike adjoining the U-abutment.

Traffic was again using new No. 2 highway after being re-routed temporarily to the old highway because of the spring thaws. Paving operations had been resumed in the various sections of the new highway with the second lift of asphalt being laid. Work also was started on No. 31 highway overpass at the relocated Canadian National Railway main line north of Morrisburg. Most of the piles had been driven and the footings had been completed for this overpass.

Installation of the transformer and switching control equipment was progressing at the St. Lawrence transformer station. This equipment is being installed now to be ready to receive power from the new generating station in the summer of 1958.

At Cardinal construction of the protective dike around the Canada Starch Company had been finished. Filling the cribs at the upstream end of the dike was the last stage of the work in this sector. Channel improvement progressed well in most areas throughout the month. Three dredges had been working in the Chimney Island contract and at the end of May the total amount of the material removed was 1,050,000 cubic yards.

At Galop Island section, excavation had been concentrated mainly in the dewatered area off the west end of the island. Work also was progressing off the east end of the island in the dewatered section between Dixon and Kellogs Island. About 12,000,000 cubic yards of earth and rock had been removed in this contract.

Removal of material from Iroquois Point was slowed down by wet conditions in the excavation area, but some 1,550,000 cubic yards had been excavated. At nearby Point Three Points, excavation was underway in full scale and favourable headway was being made.

Final house-moving was completed in Iroquois in May, with a total of 150 homes moved into the new townsite. Building of two six-unit multiple dwellings was begun. A highlight of the work at Iroquois was the official opening during the month of the new shopping centre. Temporary locations in the shopping centre had been arranged for United and Anglican Churches. Stores will be used as locale for the churches until the new edifices are ready early next year.

First stage of the house-moving operations in Morrisburg was virtually completed in May with a total of 62 homes having been moved. Work was in progress on the new Morrisburg shopping centre. Construction of the 36 rental housing units continued throughout the month.

At Ingleside and Long Sault townsites work was concentrated on grading, on building sidewalks and culverts, house painting operations and clean-up. Construction of schools and churches in these two towns was continuing.

Ontario Hydro announced early in May the appointment of William L. Fraser as field project engineer on the St. Lawrence Power Project, to succeed William M. Hogg. Mr. Fraser had been serving as project manager on Hydro's Sir Adam Beck No. 2 Development at Niagara. Mr. Hogg leaves to take a senior executive post with Great Lakes Power Company.

Progress by SLSDC

A huge underwater blast in the Detroit River on May 28 signalled the start on the $136 million upper lakes channel dredging and deepening project which will take five years to complete. Authorities have estimated the deeper channels will mean some $10 million in annual transportation savings.

SLSDC will get the additional $35 million in borrowing authority it has asked of Congress. Last week of May the House Public Works Committee approved the full request. But chances are the new total of $140 million will not finish the job, and the corporation will have to come back to Congress again for one more increase next year.

Progress by SLSA

At the end of May, concrete on the lock section of Iroquois lock was nearing completion. Two stiff-leg derricks were erected and work had commenced on installing the sector gates. Stoplogs were all delivered. The only excavation remaining was for the downstream approach wall.

At the Upper Beauharnois lock a start has been made on placing of concrete at the upstream lock entrance, while rock excavation had reached 50 per cent of completion. At the lower lock some 50,000 cubic yards of concrete were in place for the highway underpass and highway approaches, completing this portion, while placing of concrete had been commenced for both sides of the lock chamber, with 25,000 cubic yards placed to date.

Placing of concrete has also been resumed on the Cote Ste. Catherine lock, with about 130,000 yards or 37 per cent of the concrete placed to date, all of it on the lock chamber. The lock was completed to full height for about half its length, though little work had yet been done on the approach walls. Sixty per cent of the common excavation and 85 per cent of the rock excavation had been completed.

On the St. Lambert lock the downstream entrance wall was about 65 per cent completed and the lock chamber about half poured. 60,000 yards of concrete had been placed during the month of May, bringing the total to date of 190,000 cubic yards placed or close to half of the total. Installation of machinery had not yet been started but work had been commenced on the contract for excavating the regulating channel on the land side of the lock.

On the various dredging and channel excavation contracts, work was again under way, with all of them pretty well up to schedule and some of them far ahead of schedule. Dredging of the Lancaster Bar had been completed, as well as the excavation on the Welland canal between Locks 2 and 3.

Work continues on the St. Lawrence Seaway Authority's head office building at Cornwall, but with little likelihood of its being ready for occupation until late this year.

Progress on Bridges

At the end of May, with the four most southerly spans of the Jacques Cartier bridge raised some 20 feet and traffic diverted over Bailey bridges on to a temporary approach, work was about to start on raising the spans on either side of the seaway channel. A derrick had been erected on falsework just south of the channel for placing the steel towers on which the new through span will be erected alongside the existing deck span.

The superstructure will be jacked up on successive piers in six-inch lifts. Raising of the supporting piers will follow in four-foot lifts. Traffic will be re-routed from Bailey bridges to the original spans in August. By November the spans will be raised to their final position and the new span over the seaway channel will replace the old deck-span.

With the temporary rock-fill approach at the south shore end of the Mercier bridge ready for traffic, seventeen of the original bridge piers at the south end were blasted out on May 8 and traffic re-routed over the rock-fill. Work is now proceeding on building the pier foundations for the new locations of the permanent approaches, with one pier already completed to full height.

Prime Minister St. Laurent announced on May 28 the confirmation of Charles Gavsie as President of the St. Lawrence Seaway Authority, effective June 1. Also announced was the appointment of Jean-Claude Lessard, M.E.I.C., Canadian head of the Standard Railway Equipment Company, as vice-president, effective July 1.

Seaway News

Schedule Tight but Practical

Construction schedules on two phases of the seaway project were described as 'tight but entirely practical', following a meeting of the St. Lawrence Joint Board of Engineers and representatives of the four authorities concerned with its construction, at New York City on May 7.

The schedules call for raising the water level in the Long Sault pool above the international power-house, and for re-routing of ships requiring a 14-foot depth from the Canadian canal to the south Cornwall channel on the U.S. side in July 1958. By 1959 the seaway is expected to be navigable by ships with draughts up to 25 feet.

Announcement on Tolls

Acting SLSA President Charles Gavsie and SLSDC Administrator Lewis G. Castle announced on May 15 that toll committees of the two seaway authorities had been exploring various bases for assessing tolls. In developing a formula the Committees' objectives had been: procedural simplicity which would minimize cost of collection and expedite dispatching, and recovery of the cost of the seaway and its operation on a basis that would provide economical rates and encourage traffic.

Following studies of toll structures of other international waterways and of pertinent maritime rules and practices, they announced, the committees had under consideration a composite basis of toll assessment as being most suitable. Such a toll structure would encompass an assessment per ton of cargo or its equivalent, together with an assessment on the vessels' registered tonnage.

The committees were continuing their studies of traffic factors and other elements involved in the development of a tariff of toll rates, and would continue to obtain the views of prospective users of the seaway, they stated.

Gains in Port Traffic Predicted for Montreal

Dr. Pierre Camu, professor of geography at Laval University, estimates the seaway will increase shipping traffic at the Port of Montreal by between 19 and 17 per cent. He was the principal speaker at two recent luncheon meetings sponsored by the Montreal Board of Trade.

The most probable gains in shipping through the port of Montreal, he predicted, would be made in the carrying of grain and general cargo. Of the estimated 36½ million tons potential on the St. Lawrence canals, Montreal would likely gain between a minimum of 3 million tons and a maximum of 9 million tons.

Iroquois dam. Looking downstream from the Canadian mainland on Iroquois Point, Stage II construction in the foreground.

Grain, he stated, was the largest single commodity handled at Montreal, amounting to 38 per cent of total tonnage. Petroleum and oil accounted for 14 per cent and coal 9 per cent. Grain also represented 65 per cent of outward foreign tonnage and 61 per cent of inward domestic tonnage.

Atlantic Seaboard ports would lose from 30 to 50 per cent of their grain trade. Chicago and Buffalo would show gains of 13 and 15 per cent respectively and Milwaukee 6 per cent, with lesser gains for Toronto and Duluth-Superior. If grain were not trans-shipped in their local elevators, losses might be felt in lower St. Lawrence ports.

The Hon. Lionel Chevrier, speaking in Montreal on May 13, discussed the general benefits of the Seaway to the Port of Montreal.

Referring to a study made by the Indiana University School of Business and the Chicago Board of Trade on the effect of the seaway on grain marketing, he felt this recent study too important to overlook some of the conclusions arrived at. It was stated in this recent study that by 1966 the Seaway would be carrying from 150 to 200 million bushels of grain exports. Total Canadian exports would approach 200,000,000 bushels, and the combined Canadian - American volume would be in the neighborhood of 350 to 400 million bushels by the mid-'sixties'. "This, of course", he pointed out, "is the result of one study only, but it is extremely significant for the Port of Montreal in the post-seaway era".

In the area between Cote Ste. Catherine and Préville, it might be assumed that the responsible Seaway Authority would see to it that its heavy industrial potential is not overlooked, water-transportation-wise," he said. The navigation channel in the Laprairie Basin was 300 feet wide, two turning basins had been provided and both rail and motor transportation were available. Illustrations of what may happen here could be found in the tremendous industrial development along the Welland Ship canal, or along the Lachine canal where only 14 foot navigation was available.

Referring to the south shore area below Jacques Cartier bridge, the speaker expressed belief that this presently low-lying area possessed great potentialities. "These cannot, however, be fully realized," he warned, "until the ice conditions which prevail in this area have been removed. The ice conditions will be materially improved when the full power potential in the Lachine section has been developed."

Canadian Pipeline Projects

Westcoast Transmission

Construction of the Westcoast Transmission Pipeline was reported to be 85 per cent complete as on June 20, with only 100 miles left to complete. The line is now expected to be operating in August, two months ahead of schedule.

Westcoast officials have been contacting all potential gas producers in southern Alberta during May to increase gas supplies for their programs in California and the U.S. Pacific Northwest. Already Westcoast has control of half the production from the huge Savanna Creek field. Several other promising gas fields are shaping up in the southwest corner of Alberta. Demand and reserves have grown substantially since the last time export proposals from the province were studied, and further approval by a new federal government will have to be sought before additional export is allowed.

British Columbia Electric is already delivering gas to its service areas in the Vancouver area under a temporary arrangement with the Pacific Northwest Pipeline Corporation. During the coming autumn the Company expects to take more than 50 million cubic feet daily of Peace River gas via the Westcoast pipeline. This would be the equivalent of some 817,000 horsepower or almost a third of presently installed electric capacity of the entire province.

President A. E. Grauer told the Investment Dealers Association of Canada at Jasper, Alberta, early in June that his company was "working continuously at the problem of supplying Vancouver Island", and that he was "optimistic about this proving feasible."

Trans Canada Pipelines

Construction on the Alberta trunk line gathering system was ahead of schedule on the first stage by the end of May. Construction is being done in four stages and the whole system will cost $54.2 million. Work between Provost and the Saskatchewan border was under way. The submarine crossing of the Red Deer river was completed. Dutton Williams and Barker Construction Co. have the contract for the overhead crossing of the South Saskatchewan river. Fulton Bannister Ltd. had commenced clearing grading and stringing on the line from Bindloss to the Field Gate. All pipe and equipment for stages 2, 3 and 4 had been purchased on firm orders.

Under the gas transportation contract with Trans Canada, the Trunk Line has accepted a fixed payment of 4 cents per thousand feet during the development period. Based on minimum throughputs it would be three years before the company would be operating on a profit making basis. With larger throughputs than minimums set out in the contract, 'Trunk's' revenue position will improve accordingly.

Spring construction on the western section of the Trans-Canada Pipe-Line's line from the Alberta-Saskatchewan border to Eastern Canada, got under way May 9 at Pense, 15 miles west of Regina. Mannix Ltd., of Calgary, the contractor building section three of the 34-inch diameter pipe line, is now working on all phases of construction.

To speed up trenching while the frost still was in the ground, Mannix used a pilot ditching machine, followed by two more ditchers which cut the ditch to the required six feet. Although frost was not too serious a problem, the pilot ditcher often had rough going due to the heavy mud.

East of Regina, contractors were ready to start construction as soon as the annual spring road bans are lifted sufficiently to allow heavier equipment on the highways. Dutton-Williams Brothers Ltd., building section four, was double-jointing the 40-ft. lengths of pipe on the right-of-way in preparation for operations to follow. Price-Poole Limited, on section five, had completed double-jointing pipe for its section and had almost completed stringing the 80-ft. joints along the right-of-way. Pipe-laying on Sections 4 and 5 started in June. Canadian Bechtel Limited, had started on Section 6 at the end of May and was also completing double-jointing operations. On the

Red River south of Winnipeg, Marine Pipeline and Dredging was completing a dual crossing with the 34-inch diameter pipe. East of Winnipeg, Majestic Contractors Ltd., of Edmonton, was clearing and grading section seven.

Trans Canada called for tenders early in June for the 310 miles of its main 24-in pipeline between Toronto and Montreal.

Crown Pipeline Corporation

From the Ontario border to Port Arthur, Ontario, on the section of the line to be built by the Northern Ontario Pipe Line Crown Corporation, clearing, grading and other preliminary work were well under way. The Crown corporation announced the award of four contracts covering four spreads of varying lengths into which the 310-mile route between the Manitoba border and Port Arthur has been divided, involving a total expenditure of $15,556,429.

Starting at the Manitoba border, Dutton Williams Brothers Ltd. was awarded 58 miles. Spread B, the next section of 94 miles was awarded to Morrison-Shivers, Ltd. Spread C of 80.5 miles was awarded to Majestic Contractors Ltd., while spread D, of 78.5 miles into Port Arthur was awarded to Houston contracting Co. of Port Arthur.

Though almost certain to reach Winnipeg for the 1957/58 heating season, Alberta gas now appears unlikely to be delivered to the Lakehead before winter. The precambrian granite east of the Ontario border requires heavy blasting on ditches, and pipelaying will not start before July on most of the spreads. No pipe is yet delivered west of the provincial boundary. With the best of luck, pipelaying may be completed by late fall. If worst possible conditions occur, apart from any delay on pipe deliveries it may be 1958 before the first stage of the Crown pipeline is all in the ground.

Winnipeg and Central Gas Co. has announced natural gas rates in an application to the Municipal and Public Utility Board for approval of its rate schedule. The application will be heard on May 24. Some 2,500 Winnipeg homes are now heated by manufactured gas. Some 14,000 other premises have installations awaiting delivery of natural gas expected this fall. The company estimates the rates will permit heating moderate sized homes 25 per cent cheaper than with oil.

Most residential customers are expected to select the plan which permits the use of gas for all home purposes through one meter. On this plan the Company sets a price of 99 cents per thousand feet for house heating; $3.75 per 2,500 ft. for water heating; and $1.30 per 500 ft. for cooking. The corresponding rates for manufactured gas are $1.70, $4.85 and $1.45.

Jack hammers and wagon drills, operated by compressed air, preparing right-of-way in Eastern Manitoba.

Union Gas Co. of Canada Ltd. will start in mid-June on its 141 miles 26-in. diameter main pipeline in southwestern Ontario to Hamilton, Oakville and Sheridan. The line, which will cost some $35 million, is the main cog in Union's expansion program. Welland Tubes Ltd. commenced manufacturing the pipe last February.

Canadian Bechtel Ltd. has been awarded the contract and will start with at least two spreads. Initially gas will come from Panhandle Eastern via Windsor. Eventually the flow will be reversed, with Union using gas from Trans Canada Pipelines.

Northwest Nitro-Chemicals Ltd. at Medicine Hat will commence a $150,000 extension to its plant late in June. This will permit production of four new fertilizer formulations and place the company in a stronger position to develop outlets.

Pipeline News

Along the whole length of Canada's Lake Erie shore line the search for off-shore gas is being explored. The new activity has been spurred by Consolidated West Petroleum's remarkable record of successes the last two or three years in drilling opposite Port Alma. The Company has 34 wells capped, capable of producing on average span-flow potential of a million cubic feet daily per well.

Nearly 1½ million acres are involved, plans are to drill some 50 offshore wells this season between the two ends of the lake. There is a big close-at-hand market in Ontario for practically all the gas that can be produced, at delivered prices of close to 35 cents per thousand feet of clean gas. Erie is a shallow lake. Deepest well drilled so far was in 65 feet of water. Gas production comes from shallow horizons (1050-1350 feet). Drilling costs are relatively low.

CGA Sets Test Standards System

Canadian manufacturers of gas appliances will soon be doing business by mandatory Canadian standards instead of optional U.S. standards. Test specifications are now being prepared by the Canadian Standards Association and compliance with the new standards will be required by law in Ontario after September and in British Columbia after January. Other provinces are expected to follow suit later.

The only legal requirements Canadian gas appliance manufacturers have had to meet to date have been minimum safety standards set by provincial authorities, though additional performance tests were voluntarily undertaken by most reputable companies.

Import Bill Offered in Congress

A bill which would practically bar import of Canadian gas was offered in mid-May by congressman John Sager of Pennsylvania. Present U.S. law provides for Federal Power Commission approval of imports 'unless not consistent with the public interest'. The bill would hold it not in the public interest to import or export gas if it will result in economic dislocation, unemployment or injury to competing U.S. fuel industries.

FPC hearings are expected to recess in August. Expert pipeline lawyers predict they will not get down to the basic issues before October, thus hearings are expected to run well into the winter months.

The big issue in the case is whether Midwestern Natural Gas Co. shall be allowed to build a system from which companies around the areas to be served would meet fringe competition. But the question of imported gas, on which the northern half of Northwestern's project would depend, has thus become an issue in Congress.

Coal Dealers to Fight Threat of Natural Gas

The coal industry, in Eastern Canada will wage a fight for preservation of its markets from the threat of natural gas through a new organization, the Bituminous Coal Institute of Canada. An information program will be beamed initially to architects, construction firms and consulting engineers, who will be supplied with information as to competitive costs, recent data on new equipment and handling methods.

Studies will be conducted on a central heating plant idea for groups of buildings. Schools are planned for members and retail coal dealers. A comparative analysis of costs for various fuels has been distributed to those interested in the problem of fuel uses. Heating by soft coal was shown to be 28 per cent cheaper than by oil. Natural gas to compete with coal would have to sell for 42 cents per thousand feet.

In the United States in 1956 a Bituminous Coal Industry survey showed natural gas was 100 per cent more costly than coal in parts of Utah and Colorado, most of Kansas and Missouri and parts of Iowa and Illinois. Gas was 125/200 per cent higher than coal in Wyoming, South Dakota, Nebraska and Iowa. The survey, first of its kind, is regarded as merely the beginning of a general market research program. A survey for Canada, the industry claims, is needed.

Notes on Financing

Public financing by Northern Ontario Natural Gas Co. originally scheduled for mid-May, did not appear on the market until mid-June. $10 million worth of units consisting of one debenture and one common share were offered at $30 per unit. A further $15 million of financing is expected later.

Union Gas Co. of Canada will make a rights offering of common stock to shareholders of record May 23, 1957, at $55.00 a share on the basis of one common share for each four shares held. Further capital required will be provided by debt financing early in 1958.

The Stratford Theatre

The Stratford Theatre, in use since July 1 for the Stratford Shakespearean Festival, is capped by a dome roof of 150-foot span without any supporting columns within the auditorium. It is a circular building, 200 feet in diameter, with a 40-foot foyer extension running 120 feet along the front side. It is aproximately 70 feet in height, and valued at $1.5 million.

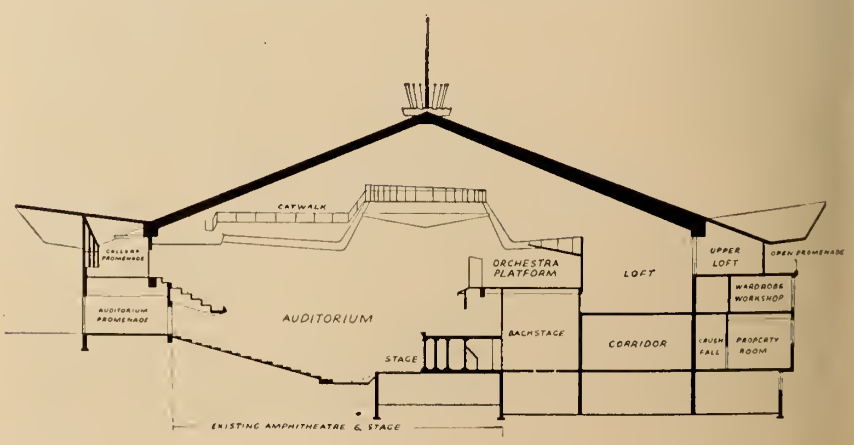
This structure was made possible by a unique engineering design which carries 34 steel beams — each 4 tons — from the perimeter wall to a centre point like spokes to a hub. A massive reinforced concrete ring beam, 4 feet square in section, running around the perimeter takes the thrust of 80,000 pounds pressure from each of these beams. In the centre they converge on a compression ring with a combined pressure of nearly 2.5 million pounds.

To assemble the beams, the steel erectors' crane with its 90 foot beam was inched through an opening in the partially completed structure over an earth ramp. Then a steel tower, equivalent to the elevator shaft for a six storey building, had to be built just to hold the roof beams in position till they could be secured, bolted and welded into a permanent support. The steel tower was then dismantled and the steel erector's crane inched out of the building interior.

Each of the 34 steel beams is actually a roof assembly with trusses and supporting members attached to the beam's 75-foot span. These assemblies were prepared on the ground and erected complete.

The building of the completely round theatre was undertaken by the Foundation Company of Canada, at a profit of one dollar, the work to be done between the closing of the 1956 and the opening of the 1957 seasons.

New Theatre for Stratford Shakespearean Festival



The festival had outgrown its tent theatre.

The distinctive design of the new building, meant to carry on and contribute to the already well known artistic and festival atmosphere of the Stratford productions, had also to provide the practical needs of acoustics for an audience of 2,000 seated around three sides of the stage, and space for a backstage area which is the best in any North American theatre.

The design and choice of materials (reinforced concrete, steel framework, and timber decking) for the 200-ton "petticoat" roof was described by Charles Hershfield, M.E.I.C., of Morrison, Hershfield, Millman and Huggins, consulting structural engineers, in a paper given at the recent annual meeting of the Institute.

Six basic devices are employed for the acoustics. The most important is the curve of the ceiling. The undulating conical pattern of the roof is repeated in the design of the ceiling. The conical facings tend to spread out the sound. A curve upwards some distance in from the perimeter is calculated to reflect and disperse the stage sounds back into the auditorium behind the actor.

There is a 30-foot diameter ceiling centrepiece of composite fibre glass panels in honeycomb design, which forms an acoustic shield to disperse the orchestra tones back into the auditorium like a lighting fixture reflector.

Serrated walls on either side of the stage, and a ring of acoustic treatment on the outer perimeter walls of the auditorium are other important aids. The walls have been specially treated with surface materials which will absorb rather than echo sounds.

The side walls, stretching from the stage back to the perimeter and separating the backstage activity from the audience, are faced with perforated and ordinary plywood in a pattern designed "to make the reverebation time of the auditorium correct at all frequencies".

The theatre structure has been built around and over the existing concrete bowl which served as auditorium seating for the original tent theatre. But the bowl had to be cut back to enlarge the back stage area, and tent columns and supporting bases had to be removed, as well as the reinforced concrete where the bowl was foreshortened. Foundations had to be dug and poured against the existing bowl; scaffolding and forms had to be assembled around and above it.

What Goes On

Industrial Leaseholds

It will take about three years to complete an apartment and office project in Toronto the plans for which were announced recently by Industrial Leaseholds Co. Ltd.

The site comprises an open cut subway strip over half a mile long, the subway retaining a permanent right of way under the development. The site, running parallel and adjacent to Yonge Street, will have eight nineteen-storied apartment blocks and two office blocks each of 14 stories.

The buildings will be set centrally and over the subway cut, which will be covered in and landscaped. They will be on modern type stilts. In size (3,312 rooms in 1,630 apartment units and 492,800 square feet of office space) the project is reported to be the most ambitious of its kind in Toronto.

Also under consideration is a slum clearance redevelopment project in downtown Toronto, known as the Queen-Sumach Redevelopment.

Winnipeg Airport

Close to $10 million will be spent on expansion of the Winipeg airport it was announced in May by the Department of Transport.

First stage would be the completion of plans for the Air Terminal Building, costing some $5 million. Architects were appointed.

The Department planned to construct this year a power-house, an equipment garage, radio and radar facilities at a cost of approximately $500,000. One runway is to be extended to 8700 feet and a new taxi strip constructed, at a cost of over $2 million. A temporary expansion of the terminal building is to be built this summer.

Surveillance Radar

Montreal airport has the first unit of the Department of Transport surveillance radar program, planned to provide radar coverage in the vicinity of major air terminals and airways across Canada. It was officially commissioned in April.

Similar units are being installed at Toronto, Winnipeg and Vancouver airports and eventually long-range radar coverage for airway operations will be installed at fifteen major air centres from coast to coast.

Algoma Steel Corp.

The interests owning stock in Algoma Steel Corp., having purchased them from the estate of the late Sir James Dunn are: Mannesmann International (200,000 shares), A. V. Roe Canada (150,000 shares), McIntyre Porcupine Mines (50,000 shares), and Locana Corp., a private U.K. banking firm (50,000 shares).

Financial Post, May 18

M-H-F Acquires Machinery Firm

Massey-Harris-Ferguson Ltd., has purchased the assets, patents and designs of Mid-Western Industries, Inc., Wichita, Kansas.

Mid-Western operations will become part of the M-H-F industrial division, general manager of which would be Charles J. Davis, president of Mid-Western. Present Mid-Western

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A concrete chimney, 554 feet high is part of the St. Lawrence Cement Company plant at Clarkson, Ont., officially opened on June 12, 1957. Over a million dollars was spent on special traps within the chimney to reclaim all waste. Their effectiveness is such that less than one per cent of the plume from the stack is waste. The constant plume is almost entirely steam. The photograph was contributed by Ciment Fondu Lafarge (Canada) Ltd.

personnel will be retained in manufacturing and marketing operations.

Financial Times, June 7

Electronic Mill

Canadian Westinghouse Co. Ltd., has received a $3,000,000 order from Algoma Steel Corp. Ltd. to build a huge electronic brain to run a proposed new combination plate and blooming mill.

The project is scheduled to be completed in 1959.

Financial Times, June 7

Nichols Chemicals

Nichols Chemical Company will build a special chemical plant at Valleyfield, Que., which could make Canada independent of foreign sources for a large number of fine chemicals now used in tonnage quantities by the industry itself and by many industries having chemical processes.

Manufacturing such products as metallic and alkali fluoborates and fluorides, nitrates, sulphates and acetates, the plant will serve such industries as electroplating, aluminum, metal finishing, uranium, rubber, automotive and plastics. The sixth major expansion in two years for the company, the new plant is expected to be producing in December.

Financial Post, June 15

Canadian Pacific Airlines

One hundred passengers flown at a time at 400 m.p.h. over the polar route will become a routine matter for the Canadian Pacific Airlines when the mammoth Bristol Britannia airplanes begin their service in the late autumn of this year.

Like any other flying equipment, the planes will undergo rigid inspections and tests before going into service, according to Ian Gray, director of engineering and maintenance, of C.P.A., who recently addressed the Vancouver Branch of the Engineering Institute of Canada.

Overseas Telecommunications

From the new building in Montreal of the Canadian Overseas Telecommunications Corporation a two-way flow of communications links Canada with the world.

This is the headquarters opened in March this year for the publicly owned C.O.T.C. and its domestic affiliate, Canadian Pacific Telegraphs.

VHF Radio Signals In Hydro Plant

Very high frequency radio signals are being used for automatic control of two of Nova Scotia's nine hydroelectric generating plants. R. H. Ferguson and W. H. H. Dean, of Canadian Westinghouse Co., Ltd., Hamilton, Ont., reported recently that utilization of a mobile voice communications band for this purpose was introduced for control of hydro plants at Nictaux and Paradise, because power line carrier was impractical and microwave is often uneconomical when only a small number of channels are required.

In their paper, "Remote Control of Generating Stations over Radio Channel", given at the summer general meeting of the American Institute of Electrical Engineers, they said the VHF in the 152-174 mc band was in existence between the control station at Hell's Gate and the two generating stations in question. "Using this installation, a field survey was made, from which it was concluded that the use of standard designs of high gain antenna would ensure a transmission circuit of the required reliability using standard FM radio transmitter and receivers," they observed. "The novel feature of this installation was the integration of the radio equipment and the supervisory equipment."

The authors pointed out, however, that utilization of a voice communications band for supervisory work may not have very wide application because of licensing restrictions.

The hydro plants supply only a third of the electric energy used in the Province, but their operation at maximum efficiency will play an important part in the over-all generating operation for many years, they said.

Epoxy Resins

The use of Epoxy resins in the electrical industry are many and varied, and range from the many life saving jobs, as they are called, to the toughest of tooling applications.

The Engineering Laboratory at the Peterborough Works of Canadian General Electric Company, in conjunction with engineering and manufacturing components, has produced a number of satisfactory applications for these materials, and is constantly working on new ones.

Among the successful tooling applications that have been developed is a forming die for forming steel fan blades .180 inches thick. This die, made from glass reinforced Epoxy has produced some 2500 parts and is still serviceable. Other types of tooling such as drill jigs, holding fixtures and checking gauges and some types of structural parts, can also be produced by using the Epoxy resins.

The life saving type of application is that with which parts that are in short supply can be duplicated to help production people meet their schedules and shipping dates, or repair broken instruments and other types of cases and porous casings, or rectify miscellaneous errors that occur in the shop.

The general properties of the Epoxy resins are quite well known and any attempt to list any formulations here as a guide would not be feasible, because different hardeners, fillers, curing temperatures, time and additives, all have definite and different effects on the final properties of the cured resin.

The use of these materials in industry of almost any type is virtually unlimited, and the development of new fillers, hardeners, etc. combined with more know how in their use, will broaden the field in which they can be successfully used. However, in many cases it will be necessary for the engineer to design for the use of these materials, instead of trying to make the material fit in with the present design.

There are some difficulties encountered in using the Epoxies. Among the foremost of these are the high cost of suitable production molds and the exotherm generated by the reaction, and the handling problem caused by toxicity of resins and hardeners used.

Prepared by R. W. Parnell,
Engineering Laboratory,
Canadian General Electric,
Co. Ltd.

Annual Meeting At Banff

An Unqualified Success

This resumé of the events at the seventy-first annual general and professional meeting of the Institute is a preamble to the full report which will appear in the next issue of the *Journal*.

Four engineering societies were represented at Banff by this group. Left to right: Mrs. M. G. Lockwood,, M. G. Lockwood, Houston, Tex., president, American Society of Civil Engineers; Mrs. McKillop, V. A. McKillop, retiring president of the E.I.C., Mrs. Coover, T. A. Crowe, Glasgow, Scotland, immediate past president of the Institution of Mechanical Engineers, and M. S. Coover, president of the American Institute of Electrical Engineers.

The seventy-first annual meeting, at the Banff Springs Hotel June 12-14, was an outstanding success in all respects. It created two records—it was the largest meeting of engineers ever held west of Toronto and the largest professional meeting ever held in the Banff Springs Hotel. Total registration was 1058.

From the start things functioned smoothly and this is a clear indication of the liaison and co-operation that existed between the Alberta branches and Headquarters staff — both before and during the meeting.

Early on the Monday morning "Operation Banff" commenced to function. On that day there were conferences of officers, staff, committeemen and all arrangements were finalized.

On the morning of Tuesday the 11th, student delegates met, with Jim Harris of Toronto acting as moderator. At the same time the branch officers and the university engineering faculty members opened their meetings and the annual meeting of Council was convened. All these meetings aroused great interest and provoked excellent discussion and conclusions.

The meetings adjourned at noon for a brief visit with "Muriel" and luncheon. After lunch the meetings resumed their deliberations and the registration desk opened.

At 7.00 p.m.—the President's reception and dinner were held. Among the guests were M. S. Coover of Ames, Iowa, president of the American Institute of Electrical Engineers, and Mrs. Coover, T. A. Crowe of Glasgow, Scotland, immediate past president and official representative of the British Institution of Mechanical Engineers, and M. G. Lockwood, Houston, Texas, president of the American Society of Civil Engineers, and Mrs. Lockwood. Past presidents of E.I.C. in attendance were V. A. McKillop, R. E. Heartz, D. M. Stephens, John Finlayson, T. M. Hogg, L. F. Grant, J. B. Stirling, James A. Vance.

"Muriel" went into operation again during the evening and by nine p.m. every province of Canada and many of the states of the Union were represented at this pleasant and informal gathering.

At 10.00 a.m. on Wednesday June 12, the Annual General Meeting of the Institute was opened by President McKillop. It was well that it had been arranged for this meeting to be held in the ballroom of the hotel as the attendance of members constituted another record in E.I.C. history. The advance printing and distribution of the Annual Report again proved to be a great asset. It facilitated the presentation of reports and provided time for questions and answers without the necessity of running into "overtime". At 12.00 o'clock the meeting adjourned for refreshments and a pleasant, informal luncheon under the chairmanship of annual meeting committee chairman W. A. Smith of Calgary.

At 2.00 p.m. the technical meetings opened. Ten papers were presented on Wednesday with some of the sessions going on simultaneously. This procedure prevailed throughout the meeting and made it possible to have a total of 34 tech-

Representatives of the engineering faculties of seventeen Canadian universities attended the education conference which was part of the annual meeting. Here are some of the delegates (from front row, left): D. L. Mordell, McGill University; President V. A. McKillop; H. G. Conn, Queen's University; J. A. Harle, University of Alberta; J. W. Hodgins, McMaster University; J. F. M. Muir, University of British Columbia; Jacques Laurence, Ecole Polytechnique; L. P. Bonneau, Laval University; A. E. Macdonald, University of Manitoba; M. L. Baker, Nova Scotia Technical College; W. E. Lovell, University of Saskatchewan; I. M. Beattie, University of New Brunswick; E. E. Goldsmith, Carleton College; R. A. H. Galbraith, University of Ottawa.

nical presentations and a management panel discussion before five p.m. on June 14. Many phases of engineering work were covered by the speakers but the emphasis of the meeting was on Canadian oil and gas.

Vice-President R. M. Hardy of Edmonton chaired the dinner on Wednesday evening at which retiring President V. A. McKillop was the speaker. It is hoped that Mr. McKillop's address can be published in an early issue of the *Journal.*

Thursday's technical presentations finished at noon and during the afternoon a golf tournament and a bus tour through the mountains formed the program.

That evening the annual dinner of the Association of Consulting Engineers of Canada and the "E.I.C. Petroleum Dinner" were held simultaneously. At the Institute dinner the speaker was C. O. Nickle of Calgary who gave a clear and concise picture of the past, present and future of oil and gas developments in Canada. J. C. Sproule of Calgary was the chairman.

Following the two dinners there was a presentation of the "Pipeline Musical Revue" — written, produced, sung and acted by the wives and members of our Calgary Branch. This show was one of the entertainment high-lights of the meeting. It was topical, tuneful and clever—and the enthusiasm of the audience equalled that of the performers.

Throughout the Thursday morning the new council held its first meeting and in the afternoon the Consultants held their annual meeting.

On Friday, the fourteenth, technical sessions went on continuously from 9 a.m. until noon and were resumed at 2.00—with final papers of the meeting being presented at 4.00 p.m.

Vice-President R. L. Dunsmore chaired Friday's luncheon at which retiring president Vernon McKillop presented certificates of honorary membership in the Institute to J. O. Martineau, A. G. L. McNaughton, P. M. Sauder, and W. S. Wilson. Prizes and medals of the Institute were awarded as follows:—
Sir John Kennedy Medals to Richard Lankaster Hearn, M.E.I.C., Toronto, and to Irving R. Tait, M.E.I.C., Montreal; the Julian C. Smith Medal, to Edward Victor Buchanan, M.E.I.C., London, Ontario.

David B. Steinman, M.E.I.C., New York, was awarded the Gzowski Medal of the Institute; Douglas Tyndall Wright, Jr.E.I.C., Kingston, Ont., the Duggan Medal and Prize; George Arthur Jewett, Toronto, the Leonard Medal; William Russell Way, M.E.I.C., Montreal, the Ross Medal; and Nicholas E. Hudak, Jr.E.I.C., Toronto, the John Galbraith Prize.

Following the presentation of the awards President McKillop unveiled a stainless steel plaque commemorating Henry J. Cambie, M.E.I.C., a pioneer railroad engineer who spent most of his professional life in the west surveying and building lines for the C.P.R. through the Rocky Mountains

The "Pipeline Musical Review" was a smash hit.

Here and There at Banff

Groups from Winnipeg, Quebec, and British Columbia (below, top to bottom). The delegates shown here are: Winnipeg, Prof. W. F. Riddell, J. P. C. McMath, K. J. Fallis, Brandon, R. E. Chant, W. R. McQuade, Ian Fraser, W. L. Wardrop; Quebec, C. C. Louttit, Arvida, E. B. Schaefer, Montreal, B. O. Baker, Quebec, and G. M. Boissoneault, Montreal; British Columbia, Percy Bland, Vancouver, T. T. Dobie, Trail, T. W. Lazenby, Trail, R. H. Carswell, Vancouver, A. C. M. Davy, Vancouver, and W. G. Small, Trail.

In the groups above, some people taking active parts in the annual meeting. Top, the new president, C. M. Anson (second from left) with three of his officers, Vice Presidents G. M. Dick, Sherbrooke, Que., S. C. Montgomery, Trail, B.C., and H. R. Sills, Peterborough, Ont.

Centre, some of the ladies who graced the proceedings: Mrs. R. C. Jarvis, Mrs. V. A. McKillop, Mrs. H. M. Hunter, chairman of the Ladies' Committee, Mrs. C. M. Anson, Mrs. K. W. Mitchell, and Mrs. B. A. Ellis.

This group of friends of the Institute includes Past-President R. E. Heartz, Mrs. Stirling, Mrs. Dunsmore, Past-President J. B. Stirling, Mrs. Heartz, and Past Vice-president R. L. Dunsmore.

and Fraser Canyon. The plaque will be permanently located in the C.P.R. station at Vancouver.

The Management Panel, held in the afternoon was an outstanding success—Bruce A. C. Hills of Montreal, president of Urwick Currie Limited, was the chairman. His panelists were R. A. Emerson, Montreal, vice-president, operations and maintenance, Canadian Pacific Railway; D. M. Stephens, chairman and general manager, Manitoba Hydro Electric Board; A. L. Bishop, president, Consumers Gas Ltd., Toronto; W. H. Young, manager Chemical-Metallurgical Division, Sherrit Gordon Mines Ltd., Fort Saskatchewan, Alberta.

The Annual Banquet on Friday night was, according to members who have attended many such Institute affairs, one of the most colourful and best arranged events they have attended. The head-table guests were "piped-in" by a lady piper — and they were a true representation of the engineering profession — and its many phases — of Canada, Britain and the United States. Mr. Justice S. Freedman of the Court of Queen's Bench, Manitoba, was the speaker and he based his address on Canadian and world events during the first seventy years of the Institute—1887-1957. His humor, pathos, descriptions, and conclusions held his audience throughout his presentation.

The formal part of the evening concluded with Vernon A. McKillop turning over the presidency of the Institute to Clement M. Anson. This was done before an audience which gave Mr. McKillop and Mr. Anson a standing ovation. Immediately after this dinner the annual E.I.C. ball commenced.

Throughout the meeting the ladies had a program of interesting and entertaining events, arranged for them by a ladies' committee headed by Mrs. H. M. Hunter of Calgary.

On Wednesday morning there was a meeting of the representatives of the E.I.C. Engineers' Wives Associations. In the afternoon they witnessed a demonstration and heard an explanation of the manufacture of petrochemical products for domestic use. The Thursday morning these activities were resumed. A bridge tournament and tea were held Friday afternoon. There were well-timed coffee parties throughout the three days of the meeting and the program was so arranged that the ladies were with the men at all the principal luncheon and dinner functions. As a souvenir of the meeting all the ladies were presented with ceramic lapel pin made from Alberta products.

On the Saturday morning many of the engineers and their wives left for tours of some of the Alberta oil fields and parts of the Trans-Canada Highway.

A special note of thanks is due to the public relations department of the C.P.R. which provided the photographers who made an excellent pictorial record of the meeting; and to those firms and members who supplied photos for the display depicting Canadian engineering work completed or in process during the past year. Industry was again very generous in its support of "Muriel".

A more detailed report of other phases of the meeting will be printed in the next issue of the *Journal* and most of the technical papers presented will be made available to all members through the same medium.

This is the retiring council of the Institute which met at Banff on June 11. Many of these officers will also be in the new council.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE
ELECTIONS AND TRANSFERS

ASME-E.I.C. International Council

The International Council held its regular semi-annual meeting in Montreal, May 6.

Present to represent ASME were W. F. Ryan, president, A. G. Christie, chairman of the Council, Thompson Chandler, vice-chairman, C. E. Davies, secretary, T. A. Marshall, Jr., assistant to C. E. Davies, O. B. Shier, 2nd deputy secretary of the society.

Representing the Engineering Institute of Canada were V. A. McKillop, president, H. G. Conn, of Kingston, G. N. Martin of Montreal, L. C. Sentance of Hamilton, H. S. Van Patter of Montreal and L. Austin Wright, general secretary.

One of the outstanding pieces of business was the signing of an amended co-operative agreement. This agreement was prepared first in 1943 and at this most recent meeting the various clauses were brought up to date.

Discussions took place on the possible means of further co-operation in both Canada and the United States. Reference was made specifically to the lubrication conference which is taking place in Toronto in October and to the solid fuels conference of ASME taking place in Quebec City also in October.

It was agreed that the third ASME-E.I.C. Education Conference would take place at the University of Michigan, Ann Arbor, on October 16 and 17, 1958. It is planned that the Conference will deal with such subjects as the continuation by colleges of postgraduate education in industry and the training of technicians and the accrediting of engineering curricula, etc. The overall title to the theme might be "The Place of Industry in Engineering Education".

Cover Picture

Two presidents of the Engineering Institute, at the annual meeting in Banff: C. M. Anson (left), who took office for 1957-58, and V. A. McKillop, retiring after a year of distinguished service.

Canadian Pacific Railway Photograph

President of the E.I.C., V. A. McKillop (left), and President W. F. Ryan of ASME, sign co-operative agreement.

Considerable time was spent discussing the possibilities of arriving at a reduced joint fee for membership in both organizations, particularly in relationship to the students. This is quite a complicated problem but it was agreed that settlement would be reached by the time the next conference takes place in the fall of the year.

Consideration was given to the future developments of the mechanical engineering field in Canada. It was emphasized that with Canada's great industrial development the numbers of engineers and their needs would increase substantially. It was hoped that ASME could be of assistance to the E.I.C. in meeting this great expansion.

At the conclusion of the conference a reception and buffet supper were held at the University Club for the ASME members in the Montreal area. Following that, the group adjourned to the auditorium of the Engineering Institute where short addresses by the two presidents were given and a great many questions were asked and answered relative to ASME affairs in Canada.

The next meeting of the International Council will take place in the United States at the annual meeting of ASME.

Aviation Writers Meet Again

The nineteenth annual meeting of the Aviation Writers Association was held late in May in St. Louis, Missouri. Following the well established pattern the meeting was made up of five days packed with events of interest and importance. The program included lectures, speeches, plant visits, special air flights and lots of discussions.

Although the center of the convention was in St. Louis, one day was spent at Kansas City, Missouri, and another day at Wichita. At both these centres there were special objects and events to be seen.

The Canadian delegates flew in a great variety of machines, including Viscounts, helicopters, fighters and troop carriers, jet transports, etc.

There were exhibitions of all types of plain and fancy flying, including a flight in a small rubber plane that was blown up with air but with absolutely no rigid framework.

The conclusion of the meeting was so close to the deadline for material for the July *Journal* that it has been impossible to prepare any for this issue other than this short reference. It is planned to have more details of the machines and other events in later issues.

"Daylight through the Mountain"

Here is a further reference to the biography of the Shanly's which the Institute is publishing. It is both a comment and a quotation. It shows something of the material contained in the book, and it is hoped, will encourage members to read the book itself. The book is now on sale at Headquarters and at the book stores. To members of the Institute it is available through Headquarters only at $5.00. The regular price is $6.00 (Ed.)

The Irish and Construction

It was a 'great day for the Irish' when they started to build railways in Canada. It is true that many played their part with a 'peck and shevell'; but it is also accepted that if you wished to see the foreman you had to ask for Mike. He was there to see that the work was done right or he would have nothing to do with it. This was partly window dressing on Mike's behalf; but it must be recognized that the Irish brought with them considerable talent for construction work. Nor did that ability stop at the foreman .level, for the engineering of both railways and canals in the older parts of the Provinces of Quebec and Ontario was largely designed and executed by natives of Ireland.

We are well aware of the inherent talent of the Irish in the realm of poetry, music, acting and oratory; but in engineering they have not received as frequent notice as they deserve. Such talent is not remarkable when it derives from the environs of old centres of civil law where property was standardized and accurate lines drawn between mine and thine. This was not so in early Ireland for, under the clan system, property was for the use of the clan and lines were not closely drawn within its territorial limits. When these latter changed it was usually by force, followed by long recollections of despair from the evicted.

English invasions of Ireland, over a period of centuries, caused temporary dislocations, without much orderly change, until 1641 when three fourths of the land in that island was confiscated. Little was done at that time to change the appearance of the country until ten years had passed. The matter was brought to a head by Oliver Cromwell's discovery that the Royalists were gaining strength in that quarter. After routing his enemies, Cromwell saw in the great tracts of deserted lands an opportunity to pay off his soldiers. He picked William Petty, a young physician trained at Leyden and Oxford, to survey and plot the Irish land into three and five acre parcels.

Petty must have assembled all the able-bodied surveyors in England as well as some from France, for in thirteen months he had mapped, plotted and recorded one-half of the land in Ireland. The document produced is still known as "The Down Survey". That the work was well done by a group selected for their ability is witnessed by the statement of Sir Thomas Larcom when editing it in 1851. He said that the survey "stands to this day with the accompanying books of distribution, the legal record of the title on which half the land in Ireland is held; and for the purpose to which it was and is applied it remains sufficient".

The surveyors were paid off in Irish land, which many of them accepted, to become citizens of that island. It is this association that may have revealed itself almost two centuries later when such high engineering skill came forth as it recognized in the names Shanly, Killaly and Tully. When the age of canals was about to begin in Ireland, it was soon evident that citizens of that island were not only able to acquire engineering knowledge with understanding but also to add to its total by creative talent. John Killaly was named Chief Engineer of the Irish Board of Works in 1792. Forty years later, his son, Hamilton, came to Canada where he became Minister of Public Works in 1841.

Hamilton Hartley Killaly became the first chairman of the group of engineers and architects who combined to form what is now the Royal Canadian Institute in 1849. It was the first organization of its kind in Canada and Killaly's interest in it sprang from his genuine interest in engineering education. He had for some years before maintained an unofficial school of engineering within the Provincial Board of Works. Happily, the brother of an illustrious uncapped and ungowned graduate from the Killaly School saved the correspondence which passed into his hands during outstanding construction work upon which they were engaged, a century ago.

Shanly Deals with Human Element

In these letters, mostly from Walter Shanly to his brother Francis, there are revealed not only many of the methods of securing their supply cf materials, the methods of fabricating it into durable structures, but chiefly the method of mastering the human element as met with in the persons of both employees and superiors at the various levels. Machinery and materials change, but the nature of man does not at the fundamental level. In this latter regard, the pages of opinions and estimations poured forth by Walter Shanly a century ago are just as true today as when they were written.

During the early days of his engineering responsibility, Walter Shanly used to rehearse his plans on paper by writing to his brother. If we take a glance at his thoughts as Chief Engineer, preparing to build his first railway, the Bytown & Prescott, we find him trying to have Francis return to Canada from a canal enterprise upon which he was engaged in Pennsylvania so that he could divide the burden. Early in February, 1851, he wrote, "My first troubles are about to commence as there will doubtless be an outcry about my employing Yankees . . . I think there is going to be a good opening in Canada and I mean to put the "Bytown" through by daylight. My intention is to make the cheapest possible kind of road, trestle across brooks and valleys and have hardly any masonry. I will put up temporary wooden work at all the crossings leaving room enough to build in the masonry afterwards. If I can only have a *good track* down and a train of cars over the Road in 1852, my fortune is made in Canada and I should not wonder if I had to finish the Western for them yet . . .

"The Montreal and Prescott is pretty sure to be surveyed anyhow and the whole country is astir from here to Toronto. I am, I fear, a victim of treachery. I told you in my last that Tom Keefer showed himself anxious to keep me in the Bytown affair and told me that he would on no account undertake Location, as his health was not good enough. He was here last week and spent the evening with me and coolly informed me that he is to have the Montreal and Prescott. So that his object in forwarding my views at Bytown was simply to get me out of the way . . .

"Dana is a hard-up man and I suppose you will just have to take Peter back and say nothing about it. I wish I had him now instead of hiring horses to take me to Bytown. I would offer to buy him only I think Dana would want cash down.

As ever, W. Shanly."

Great Construction Era

Two weeks later, he wrote giving the first inkling of the great construction era upon which the Government of Canada was about to launch. He had had a letter from their brother Charles, a clerk in the Board of Works. He wrote, "There is still much excitement in the Province on Railway matters . . . Killaly had called upon Charley the night before he wrote. He gave his reason for calling that he wished to learn what my engagements were. The Government, he says, have it in contemplation to enter into the Montreal-Toronto Railroad scheme. In which case, they would have an engineer of their own and that he was resolved to pitch upon me as the man . . . I am the only Canadian Engineer who has any practical knowledge of Railway work and I certainly *ought* to get the place, if such a place is created.

"Anyhow, Canada is going to be good ground, and if I only had the Bytown and Prescott located and the work commenced, I would be easy in my mind . . . I must organise my Corps at an early date. I shall get my instruments from Phelps and Gurley. They say they have improved greatly, and will give me any trial I require and long credit, and after all their levels are good enough for Railway work. I may call upon your man for some stationery. Could you get me a convenient set of pocket drawing instruments when next you go to Philadelphia? I want something very nice and also 3 or 4 good drawing pens, and if you can find it, a first rate protractor with limb; but this latter article, I fancy, can just be got in New York. If I get time next month, I shall probably go to New York and if so to Philadelphia. Will you meet me?"

Walter then answers some of the questions asked by his brother regarding the canal upon which he was then engaged. "As to puddling. If you put in two feet; *good,* it will hold any head of water that you have to provide against. Where your canal is made upon embankment, you must be very careful to have the earth from *bottom to top* laid in layers and carted over, not *dumped* as in railroad embankments. *Complete the section of the canal before you commence puddling* and then dig out the place to be occupied by the puddle. Did I give you a specification for the puddling over the St. Pierre Culvert, Beauharnois Canal? That is the best piece of work of its kind anywhere, only 2 feet thick, 10 feet head of water. I think you took that specification from here. Always use gravel in preference to anything else . . .

"I am getting avaricious, I find myself in possession of the $500 required for the England trip, but fear I can't come that, unless I persuade the President to send me home for iron . . ." F.N.W.

For Senior Engineers

Back in January the chairman of the Niagara Peninsula Branch sent a circular letter to all the senior members within that branch, pointing out that their continued interest in the branch would be much appreciated.

Speaking in the words of Percy L. Climo, who is chairman of the branch, the branch had this to say:

"Do you recall your early experiences as a member of the Institute? Do you remember that, at the monthly meetings, it was a source of great satisfaction to you to associate with better known and more experienced men in the profession? Sometimes, you would get a few words with some of them but even when you did not you had the satisfaction of rubbing shoulders with them. The meetings were that much more important in your mind because such men found them important enough to attend.

"Looking back, it is easy to recognize that those men did something extra for the profession which, perhaps, they did not themselves realize. By their example and their interest they encouraged the younger members to gain some knowledge of the broader aspects of engineering, to look beyond their own immediate jobs.

"This brief letter is intended as an expression of thanks to those of you who attend the meetings of the Branch as often as you can. It is directed, too, to those others who, because of heavy responsibilities or even perhaps because of a feeling of not being needed, have tended to neglect our monthly gatherings. Think back a little and you will realize what your presence means to the junior men. Think back and recall, too, the enjoyment you got out of the meetings.

"This is a personal appeal to you to attend as many meetings this year as possible. They are never oftener than once a month and only about a half dozen in a season and yet the encouragement you will give to the younger men is immeasureable."

The *Journal* is publishing this portion of the branch message in the hope that senior members of every branch will see it and will continue or take up again their interest in branch affairs.

Athlone Fellowships, 1957

Athlone Fellows, 29 Canadian engineers who graduated this year and nine more who have spent some years in industry, will shortly be on their way to Britain. They were chosen this year by the Ministry of Education of Great Britain, whose representative, Dr. H. H. Burness, toured Canada earlier this year.

Athlone fellowships provide two years' training in industry, or two years' post graduate work at a university, or one year of each. Ten of this year's successful applicants will follow the first plan, eight will follow the second, and twenty will have one year in industry and one at university. Their subjects of study will be varied, including aeronautics, nuclear energy, metallurgy and civil, mechanical, electrical and chemical engineering.

This program, inaugurated in 1951, attracts many applications each year and has obvious and highly valued educational benefits for the young engineers selected for this advanced training. Travel, tuition and maintenance allowances are provided by the program.

As always, there are student members of the Institute in the group: M. C. Campbell, of Nova Scotia Technical College; C. Lemyre, Laval University; A. P. Jurkus and P. Fortier, of Ecole Polytechnique, Montreal; R. Fancott, McGill University; K. Vandalen, Queen's University; P. J. Fulford, and D. M. Onysko, University of Manitoba; D. W. Johnson, University of Saskatchewan; and E. V. Jull, a 1956 graduate of Queen's University.

Information about the fellowships is available from the registrars of eleven Canadian universities having engineering faculties. Applications should be made each year before January 15. Information is also available from the United Kingdom Information Offices in Ottawa, Montreal and Toronto.

Correspondence

Engineering Education

To the Editor:

Mr. E. T. W. Bailey's interesting comments in the March issue of *The Engineering Journal* are responsible for this letter, and I agree that the unspecialized graduate might be more acceptable to industry. Personally, I am convinced that a common course in engineering will be adopted before too many years in place of the specialized courses which, in general, are now being given.

An oil company executive commented that his concern preferred a graduate with a sound knowledge of geology rather than one who specialized in oil geology. His company would give the training in that field.

Mr. Bailey's idea of two sessions in one year could be carried out, but the staff problem would be almost insoluble. Queen's University had summer sessions in 1945, 1946, 1947 and 1948 and, since students could not take two successive sessions except in the first two years, the winter students, in summer, and the summer students, in winter, could be used as junior staff assistants. What made this possible was, of course, the fact that these were ex-servicemen and mature.

In regard to producing more graduates, there are two practices in the United States which are almost unknown here. (1) The cooperative colleges in that country go quite a way toward assisting a man to get a degree and, in addition, the comments from industry which work with the plan are most favourable (see "Why Industry Likes the Co-Op" by C. F. Arnold, chief engineer, Cadillac Motor Division, General Motors—*Journal of Engineering Education*, December, 1956.) A free leaflet describing the plan and listing colleges that offer it can be obtained from the U.S. Department of Health, Education and Welfare, Office of Education, Washington 25, D.C. (circular No. 463 entitled Co-operative Education in the U.S.). (2) An engineering degree can be obtained by attending evening classes in our neighbour to the south, whereas, to the best of my knowledge, that is not possible in Canada. The January, 1957, *Journal of Engineering Education* has an article entitled "Evening Engineering Education and its Contributions". On the evidence of the writer, the contributions are considerable.

In line with Mr. Bailey's statement that "the rest of the year valuable physical teaching facilities lie idle" is an article in the *Saturday Evening Post* of June 9, 1956, in which Dr. Litchfield, principal of the University of Pittsburgh, says it is silly for the average student to go to school for about thirty weeks every year and have twenty-two or three weeks off. In professional life an engineer will have only two or three weeks off. An article in *The Engineering Journal* of April, 1956, criticizes the shortness of the college year along with other items.

A. Jackson, M.E.I.C.
Kingston, Ont.

E.I.C. Annual Meeting
1958
Quebec City
Chateau Frontenac
May 21, 22, 23.

Professional Development

The fifth annual conference of chairmen and delegates of Professional Development Courses was held in London, Ontario, on Saturday, May 4, 1957.

Although all chairmen, committee members and those interested in Professional Development in all the Institute Branches are invited, this conference has come to represent mainly Ontario groups, others having transportation difficulties. This year, however, to the great pleasure of the delegates, Commodore A. C. M. Davy was able to represent the Vancouver P.D. group, which topped all the others with an enrolment of 231.

Nine Ontario branches were represented — Belleville, Border Cities, Brockville, Hamilton, London, Niagara, Port Hope, Sarnia and Toronto—by 47 delegates, who in turn spoke for about 500 members who have taken the courses in the past season in these nine branches.

President of the Institute, V. A. McKillop opened the meeting with an address commenting on the value of Professional Development. It is, he said, a symbol of what the Institute stands for.

E. V. Buchanan was the luncheon speaker, explaining the tie-in of Professional Development as sponsored by the Engineering Institute, with the work of The Engineers' Council for Professional Development (New York). Colonel L. F. Grant acted as chairman of the meeting.

Ten days before the conference, reports from the different groups were circulated, and the topic of the meeting was "Constructive Suggestions for Next Year's Course, Learned from Courses Just Completed".

Fifteen P.D. group chairmen spoke for five minutes each in turn. The interesting result was that no two dealt with the same problems and all made excellent suggestions.

Guests and delegates were invited by the E.I.C. to a luncheon in the Terrace Room of the Hotel London. Discussion resumed after luncheon and the meeting was adjourned at 3.00 p.m. Minutes of the meeting are available from the E.I.C. Toronto field office, 236 Avenue Road, Toronto.

Peterborough was chosen as the site for next year's conference, which will again be set for the first Saturday in May.

Reports from the Groups

Some highlights of the delegates' reports will be of interest.

Vancouver attracted 231 enrolments with a series of lectures on law, given by a judge and several leading barristers. Brockville's experience was that the high quality of the material presented by Queen's University speakers brought enthusias-

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Luncheon during the Fifth Annual P.D. Conference

Shown standing are guests Edgar Cross, Toronto, E. V. Buchanan, London, E.I.C. member on E.C.P.D. Council; L. F. Grant, field secretary, E.I.C.; President V. A. McKillop; and A. C. M. Davy, the new western field secretary, E.I.C.

Also present were guests D. J. Matthews, London Branch chairman; G. L. Schneider, E.I.C. member on E.C.P.D. training committee; and Mrs. Lilian Robertson, Toronto, assistant to the field secretary.

The delegates were: Belleville, T. E. Flinn, and D. B. Pullan; Border Cities, W. G. Mitchell; Brockville, H. L. Gilchrist; Hamilton, W. H. Hohn, J. A. Walsworth, W. A. H. Filer, K. R. Crean, A. I. Wilkinson, R. A. Gunst, R. F. Hall; London, A. L. Furanna, C. H. Osborne, H. Martin, W. Sinkins.

Niagara, C. A. McDonald, H. Saaltink, Robert Wright, H. C. L. Joe, F. Fernandes; Port Hope, J. A. Pollock; Sarnia, K. J. Radcliffe, M. M. Brown, C. C. Blackmore; Toronto, W. J. Mosley, T. W. A. Morris, Gordon Davidson, John Kirk, W. Breckenridge, J. C. Strang, D. Zavitzianos, Sherman Gauley, W. W. Walker, R. C. Sadler, W. A. Lardner, C. F. Millar, L. C. White.

tic audiences, and accounted for several new memberships.

Speakers for Hamilton emphasized the value of a preplanned program of material not available elsewhere. They described their integrated four-year course. London will have a two-year course, with the second year concentrated on fewer topics.

Niagara Branch plans a high calibre three-year program, with emphasis on participation of members. They will promote enrolment through E.I.C. meetings and through other groups and with the help of management.

The Port Hope secretary gave details of five meetings of last year. Sarnia will have a program in the fall. Toronto speakers expressed appreciation to the Hamilton group for their guidance on the matter of a constitution. They placed much importance on the annual P.D. conference. Border Cities reported particular interest in personnel and management subjects.

Sir Sandford Fleming, Hon. M.E.I.C.

An event which commemorated the achievements of the man who gave the world "Standard Time" was held in Ottawa on May 16, 1957, when a memorial tablet to Sir Sandford Fleming was dedicated.

A prominent engineer, educator and author, Sir Sandford Fleming died in Halifax in 1915, a man famed as a great Canadian scientist, though he was born in Scotland. He had served Canada in many important ways from 1845, when he came to this country, already a surveyor and engineer.

Sir Sandford was a director of the Hudson's Bay Company and of the Canadian Pacific Railway, and he was chancellor of Queen's University for thirty-five years. He was a charter member of the Royal Society of Canada, and its president in 1888. Many other evidences of appreciation were apparent during his lifetime — the honorary degree of LL.D. was awarded to him by St. Andrews University (1884), by Columbia University (1887), University of Toronto (1907) and Queen's University (1908). He was created a C.M.G. in 1877, and a K.C.M.G. in 1897. He was a charter member of the Engineering Institute of Canada and was made an Honorary Member in 1908.

The new tablet, placed on the Dominion Observatory Building serves as a formal acknowledgment of Canada's debt to him. Its inscription reads as follows:

"Sir Sandford Fleming, K.C.M.G., Pioneer in world communication. Engineer in charge of surveys and construction; Northern Railway, 1852-63; Intercolonial Railway, 1863-76; Canadian Pacific Railway, 1871-80. Designer of the first Canadian postage stamp, 1851. Promoter of the system of standard time, proposed 1876 and widely adopted by 1883. Advocate of the Pacific Cable and "All Red Route". One of the founders of the Royal Canadian Institute. Born in Kirkcaldy, Scotland, 7th January, 1827. Died in Halifax, 22nd July, 1915."

Attending the ceremony were Canadians from every walk of life and persons connected with the work and interests he advanced. There were also present three of Sir Sandford's grandchildren, the Viscountess Hardinge, who unveiled the tablet, and Mrs. Jean Holt and Mrs. Joan MacLean; two great-grandsons, John Sandford Fleming, and Joseph R. Fleming; two grand nieces, Mrs. C. A. E. Chapman, and Miss Maude Fleming, and Basil Hall, grand nephew.

Invited to represent various organizations were the Honourable Charles A. Dunning; Donald Gordon, president of the Canadian National Railways; the Honourable George Prudham, Minister of Mines and Technical Surveys; Marc Boyer, Deputy Minister; George McIlraith and J. T. Richard, Members of Parliament; Prof. Fred Landon, chairman, Historic Sites and Monuments Board of Canada; H. J. W. Walker, member of the Board; The Honourable Thane A. Campbell, Chief Justice of Prince Edward Island, and Board member; Lieut. General Maurice Pope; Mrs. W. F. C. Anderson, president, Historical Society of Ottawa. Col. W. A. Capelle, chairman of the Ottawa Branch, represented the Engineering Institute of Canada.

N. R. Crump, president of the Canadian Pacific Railway, outlined Sir Sandford's achievements in the building of the early Canadian railroads. He told of his discovery of the Yellow Head Pass, which is now followed by the Canadian National line. Sir Sandford was the first to demonstrate the practicability of the route through the Kicking Horse, Eagle and Rogers Passes.

Dr. C. S. Beals, Dominion Astronomer, sketched Sir Sandford's career. His advocacy of Standard Time to replace local time was a step toward his dream of an international time system for the world. Dr. Beals explained that the establishing of the observatory at Ottawa stemmed from the building of Canada's early railroads. It was necessary for the work of surveying that there should be some method of absolute time reckoning and the observatory was created to meet the surveying and scientific needs of the time.

Chairman W. Kaye Lamb, Dominion Archivist, and National Librarian, was chairman of the ceremony and of the reception.

The Historical Society of Ottawa completed arrangements for the reception, and the Dominion Observatory and the Department of Public Works assisted in the preparations for the ceremony. The tablet was erected by the National Parks Branch on the authority of the Minister of Northern Affairs and National Resources, and on the recommendation of the Historic Sites and Monuments Board of Canada.

F. M. Becket Memorial Award

An award consisting of a $500 scholarship offered by The Electrochemical Society has been announced. The winner will be chosen for the best project dealing with some aspect of eletrothermics or electrometallurgy.

Although funds for this award contributed by the electro-metallurgical division of the Union Carbide and Carbon Corporation have been set at $500 for the first year of study, it is expected that at least this amount will be authorized by the society in subsequent years.

The award may be won by any student regularly enrolled in any college, university or institute of technology anywhere in the world, in courses leading to the Bachelor of Science degree or its equivalent, who shall have completed two or more years of work toward such a degree in science or engineering at the time of making application. Applications should be submitted by December 31, 1957.

Further information on the contest may be had on writing: G. M. Butler, The Carborundum Company, P.O. Box 337, Niagara Falls, New York.

Engineering and Scientific Manpower

A summary of scientific and engineering manpower in Britain, as disclosed in a recent survey conducted by the Ministry of Labour, shows 51,230 scientists, and 68,470 engineers, or a total of 119,700. The Ministry estimates that the survey missed approximately 5000 scientists and 10,000 engineers in other employment, making a grand total of 134,700. The survey did not include technologists working abroad for British firms or in the Overseas Civil Service. In a total working population of 24 million, scientists and engineers thus comprise 0.6 per cent.

Only a partial breakdown by categories has been reported. In the private and nationalized industries, electrical engineers led with 12,200, followed by chemical engineers (8300), mechanical engineers (6700), and aeronautical engineers and associated scientists (4300).

Of the 13,850 scientists and engineers in government employment, just over one-half are in the defence departments, just over a quarter in the civil departments, and one-sixth in research departments. Of the 6,680 qualified scientists and engineers employed by local authorities, the great majority are civil engineers (80 per cent of the total).

The Ministry of Labour's questionnaire asked for an estimate of needs in the year 1959, and replies from industrial establishments indicated that their technological staffs would be increased by one-third in the three-year period, whereas the increase anticipated in government and education amounted to only 14 per cent. The greatest numerical demands were expected in mechanical, electrical, and civil engineering, and in chemistry and physics. By 1957 it is believed the need will be double what it was in 1956.

The British government appears to be alert not only to the problem it faces in attempting to increase the supply of scientists and engineers, but also to its magnitude. A five-year program of expansion of technical colleges, involving an outlay of 70 million pounds, has been planned. The principal objective is to increase by about one-half the output of students from advanced courses at technical colleges.

It might be noted, with some concern, that the entire program is apparently government-planned, government-sponsored, and government-supported. It is difficult to convey the flavour of these documents in a brief digest, but several passages must warm the heart of any American reader. For example, it is reported that, in Scotland, "The great majority of boys and girls study both mathematics and science for at least three years, and the number taking these subjects up to the level of the Scottish Leaving Certificate has increased steadily. In 1954, mathematics with 7,418 candidates, was second only to English with 8,499, and science with 4,861 occupied fifth place among the 25 subjects of the examination."

One final quotation will indicate the breadth of view with which plans are being made:

"Technical education must not be too narrowly vocational or too confined to one skill or trade. Swift change is the characteristic of our age, so that a main purpose of the technical education of the future must be to teach boys and girls to be adaptable. Versatility has been the aim of a classical education; technical studies should lead to a similar versatility and should, therefore, be firmly grounded on the fundamentals of mathematics and science. It is much easier to adopt new ideas and new techniques when the principles on which they are based are already familiar."

Abstract from the Newsletter of the Engineers' Joint Council, March 1957

Elections and Transfers

A number of applications were presented to council for consideration and on the recommendation of the Admissions Committee, the following elections and transfers were effected, on June 11, 1957.

Members: K. Bieniecki, Montreal, A. F. Bisschop, S. Africa, N. J. Campbell, Thompson Lake, N. R. Grover, Montreal, I. J. Hammill, Montreal, H. G. Hilton, Hamilton, N. Huq, Montreal, G. F. Jenkins, Toronto, R. P. Jezek, Montreal, D. Krofchak, Toronto, O. Kuch, Montreal, W. J. Malone, Ottawa, T. A. Marshall, Jr., New York, A. G. Overland, Niagara Falls, A. Poblacion, Montreal, J. Robinson, Montreal, F. J. Rolling, Montreal, H. F. Sanderson, Vancouver, R. F. Scott, Toronto, D. Simpson, Toronto, A. F. Smith, Montreal, M. Stein, Montreal, G. H. Tidswell, Galt, G. Wachmann, Montreal, S. N. White, Ottawa, A. Wyatt, England.

Juniors: R. M. McBain, Owen Sound, H. M. F. Warland, Peterborough, G. Y. Williams, Shilo, Man.

Junior to Member: O. Almoslino, Montreal, J. Chisvin, Toronto, W. E. Dowbiggin, Montreal, J. S. Edwards, Montreal, A. M. Heisey, Don Mills, W. Hemerling, Vancouver, R. A. McKay-Keenan, Ottawa, J. M. Royer, Quebec.

Student to Member: P. Corobow, Montreal.

Student to Junior: F. L. Henderson, Moncton.

STUDENTS ADMITTED:

University of Toronto: P. J. Hickson, K. L. Roper, P. D. Scholfield, M. R. Wright.

University of Manitoba: E. M. Lechman, B. C. Semchuk.

Queen's University: L. J. O'Riley.

University of Western Ontario: J. B. Robinson.

St. Francis Xavier University: A. J. Bergeron.

Student A.P.E.O.: Wm. McGilvery.

Graduate: D. A. MacDonald, B.Sc. (Elec.) N.S.T.C., 1957.

Applications through Associations

By virtue of the cooperative agreements vetween the Institute and the Associations of Professional Engineers, the following elections and transfers have become effective:

ALBERTA

Member: D. F. Abel.

Junior to Member: J. E. Davis, D. H. Evers.

SASKATCHEWAN

Members: S. Franko, H. M. Gibson, R. F. Gilmour, H. C. Harris, J. M. Murray, W. H. Roe.

Students: O. K. Aschim, J. A. Boulanger, E. W. Cleveland, J. R. Dundas, H. J. Heath, R. J. N. Henderson, J. A. Law.

Junior to Member: G. M. Pearson, H. A. Sabier, R. S. Yoneda.

MANITOBA

Junior to Member: W. G. Maclean.

NOVA SCOTIA

Member: D. J. DeVan.

PRINCE EDWARD ISLAND

Member: E. G. Daly.

Junior to Member: N. F. Stewart.

THIRTY-FIVE YEARS AGO

Comment on the Journal of July, 1922

"Lawyers, the most trusted and distrusted; the men who make contracts and unmake them; who give advice and sell counsel; who make money out of trouble and trouble out of money; who create estates and distribute them; who live by loaning money and often subsist on borrowed capital; who hear and conceal marriage secrets, and drag out faded letters in bitter divorces; who please and persuade when they are lucky, but often go out of court branded and dispraised by the side defeated, and with one side always the loser, — what wonder that the slurs of character fall to the common lot of the lawyer!

"Without the smiles of the merchant's customer, he meets the frowns of business men in trouble. No time is to be lost, no delay for fees. He must win a victory or bear the blame forever. Unlike the builder, who knows that be it ever so perfect, the elaborate house he has finished can never suit the proprietor; unlike the machinist, he controls not his own enginery; carrying the double burden for self and client; invited to win what others have failed in; urged to mend the broken pieces of an ill-made contract; bound to account for unreasonable confessions, blunders and letters; asked to replevin goods already secreted, to attach the effects of a malicious merchant, to unearth fraudulent elections, to reclaim vast estates from costly tax titles, to keep one for years in plenty by restored possession and broken wills, often on doubtful evidence by a lawyer's art and eloquence, — what a happy condition!

"Fated from the start by uncertainty, where clients exact no less than absolute victory, they long to call reasonable what they know is only probable. By logic and argument on the theory of their clients, with the facts only partly stated, and that part deeply shaded, they are often surprised by the other side and called to explain away their defeat in the end by a tirade on the perjury of witnesses and the depravity of human nature. The happy lawyers!

"The men who live so easily, flourish so long on the bounty of a grateful people, make the laws and settle the titles, defend the weak and protect the wealthy, enjoy the rich fruit of the world's praises and abuses, mingled and co-mingled in such rare harmony that none can define where censure ends and approval commences, — who would not be a lawyer?"

We could not resist the temptation to lift this quotation verbatim from the introduction to the leading paper in the *Journal* for July, 1922, "Some Legal Aspects of Engineering Contracts", by Alfred Bicknell, read before the Toronto Branch. The author was obviously a lawyer, though there was nothing to show his profession.

If this be the true feeling of a lawyer for his calling, perhaps some of those who had been demanding that engineering be given professional recognition "comparable to that extended to . . . law and medicine" were only half right in their attitude. If they could have found a doctor as frank as this lawyer, they might have decided that they were wholly wrong and that engineering could have done better than to catch at the coat tails of the accepted professions.

In this *Journal*, too, there was a paper on locating, constructing and starting an industrial plant, read before the Sault Ste. Marie Branch by F. T. Gnaedinger, A.M.E.I.C., and also the second part of the July paper on the corrosion of buried lead pipe.

Engineers' Act Passed

A revised version of Clause 34 of the Ontario Engineers' Act was passed by the provincial legislature, the sections objectionable to the politicians having been deleted. These prohibited practice as an engineer, usurping the functions of an engineer, or acting in such manner as to suggest that the offender was an engineer, all offences which the backers of the bill thought ought to be penalized, but which seem not to have impressed the legislators as serious. The modification took a good deal of its authority out of the Act and were accepted by engineers only as a matter of *force majeure.* The complete text of the Act was also published in this *Journal.*

Technical Committee

The Committee on the Deterioration of Concrete in Alkali Soils, under the chairmanship of Dr. C. J. Mackenzie, now HON. M.E.I.C., met in Calgary, in June, 1922; its proceedings were reported in this *Journal.* Although there were much useful discussion and several trips to inspect concrete structures, the Committee was not ready to make any definite recommendations.

Col. Boyden, the Portland Cement Association's peripatetic lecturer, was still touring the branches, and Professor Duff Abrams himself was also visiting some of them. During June one or the other of them had spoken before the branches in the Border Cities, Ottawa and Calgary.

This Journal reviewed the "first book" of the Canadian Institute of Chemistry, a "record to the . . . progress resulting from the . . . efforts of those men of science who conceived the idea and made possible this much needed organization."

H. L. Seymour, A.M.E.I.C., had a page or so of town planning notes, as usual. One of his bits of information was that every city in the United States of over 300,000 population had adopted town planning as part of its official program by 1922.

Wilson Tayler, A.M.E.I.C., favoured the editor of the *Journal* with a long letter purporting to explain "the location of (the) energy which is hidden or 'latent' in . . . steam." He wrote as one with authority, but I must confess that in the short time I devoted to his letter, I got precisely nowhere. Mr. Wilson promised a more extended exposé of his ideas in the *Journal* for August, 1922, but there was none. If submitted, perhaps the paper foundered in the Publications Committee, which has always had a hard time to distinguish between novel ideas of value which ought to be promoted, and those which may be called "crack pot" and have no place in the *Journal,* like a paper offered us not so many years ago on the organization of the cosmos, based on the uncompromising statement that the earth is flat.

R. DeL.F

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

DOMINION COUNCIL

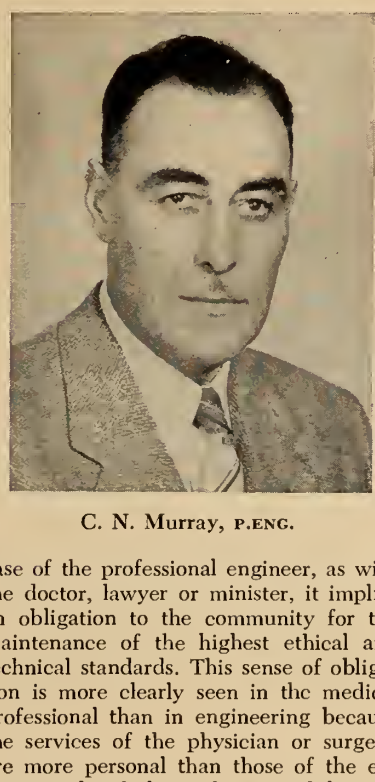
N.S. Man President

C. N. Murray, P.Eng., of Sydney, N.S. was elected president of the Dominion Council of Professional Engineers at its three-day annual meeting at Halifax, succeeding E. J. Durnin of Regina. The 30,000-member Council represents the engineering associations of the ten Canadian Provinces and the Yukon.

General superintendent of the Dominion Steel and Coal Corporation, at Sydney, Mr. Murray served as president of the Association of Professional Engineers of Nova Scotia in 1956.

Mr. Murray joined the Dominion Steel and Coal Corporation as an instrument clerk shortly after his graduation in mechanical engineering from the Nova Scotia Technical College. In 1943 he was appointed superintendent of blast furnaces and was subsequently named assistant to the general superintendent.

Also serving the Engineering Institute Mr. Murray is a past-councillor of the Institute and a past-chairman of the Cape Breton Branch of the Institute.



C. N. Murray, P.ENG.

QUEBEC

Address by Dr. O. M. Solandt

In his address to the Annual Meeting of the Corporation of Professional Engineers of Quebec on March 23, 1957, speaking on, "Some New Responsibilities for the Professional Engineer", Mr. Solandt said that undoubtedly one of the most pressing tasks that confront the engineering profession today is the training of more engineers to meet the growing needs of Canada's rapidly expanding industrial economy. An essential and difficult part of this task is to ensure that the high standards of engineering education and of professional conduct we have achieved in Canada are not only maintained, but even improved during this growth. We are rapidly becoming a highly industrialized nation, and more and more engineers will be engaged on projects that take them to the very frontier of existing scientific knowledge. The distinction between the scientist and the engineer, is fast disappearing. But, important as is the task of producing more and better engineers, it is of much less fundamental importance than some other tasks that confront the engineering profession.

Fostering a Spirit of Engineering. The first of these is the fostering of the essential spirit of engineering as a true profession. The word professional is much misused nowadays, but in the case of the professional engineer, as with the doctor, lawyer or minister, it implies an obligation to the community for the maintenance of the highest ethical and technical standards. This sense of obligation is more clearly seen in the medical professional than in engineering because the services of the physician or surgeon are more personal than those of the engineer. This feeling of responsibility for the use of a body of knowledge by a group of specially trained individuals has been expanded into the whole concept of a profession with its high standards of honesty and integrity and of self-discipline and discipline by the group.

It seems that this basic concept of professionalism might be extended to include almost everyone in a modern community. Professional organizations have always quite rightly sought to foster the interests of their members along with the interests of the community. Unfortunately, in a few cases they have become devoted entirely to the promotion of the selfish interests of their members.

But if we look at the world today, the greatest cause for apprehension is not a decline in the sense of responsibility of educated and other privileged people. It is the way in which man's mastery of his environment is outrunning his social organization. Scientists are now making discoveries and engineers are applying them, both for war and for peace, at a rate which far exceeds the capacity of our society to adapt to them. This has led to the state of continuous industrial revolution that is referred to as automation, and in the field of war it has led to a state that has been called a "balance of terror" due to the perfection of the hydrogen bomb.

Ultimate Effects Agreed Upon. Everyone is agreed that the ultimate effects of automation can be beneficial to every part of the community. It will increase productivity and real wages and give more people interesting and challenging jobs. Until recently, our western civilization has been able to absorb and adjust to new machines as fast as they appeared. However, new means of eliminating men in productive and clerical jobs, have appeared so rapidly that we must take care to see that too rapid automation does not produce transitory disruptions of our social organizations.

Unfortunately, there is something radically new about thermonuclear bombs. Their destructive power is far greater than that of any previous weapons. In a future war there is a real chance that civilization and even the race might be wiped out. The stakes are now so high that man cannot risk another war, and the possibility of war still exists.

Rapid Evolution of Social Organization Important. We can only avoid destruction by the rapid evolution of the social organization of the world to keep pace with the realities of the hydrogen bomb. Our ultimate objective must be some sort of world state in which we have the same acceptance of the rule of law and of its enforcement as we now have in our own communities.

This ideal will only be attained when ordinary men all over the world fully comprehend the threat of the bomb and also understand the promise of abundance that is held out to mankind by the discoveries of science. More than any other group in the community, engineers must accept responsibility for the interpretation of scientific discoveries to the man-in-the-street.

But there is another related aspect of this problem that looms even larger. Science and engineering are among the most attractive and exciting careers open to young men and women today. We are making careers in these fields even more attractive by increasing monetary rewards and social prestige. Even in the past twenty-five years a high proportions of the able people in Canada and in the world have gone into science and engineering. Prior to that era, many of the most competent young people took courses in the classics or history and became leaders of church and state.

Leaders of Vision and Understanding a Requisite. The greatest need in the world today is for leaders with vision and with understanding, both of man's past efforts to eliminate the need for war and of the broad significance and possibilities of modern scientific development. It is another of the duties of the engineering profession, and possibly the most important one, to share in the task of finding, training, and supporting these leaders. An increasing number of community, national and world leaders will come from the ranks of scientists and engineers.

But we must not let our enthusiasm for science and engineering lead us to feel that we can solve these problems alone. We must also encourage the pursuit of the classics, history, art, literature and the social sciences, so that Canada can offer the world leaders with diverse background and experience.

The only thing that can cut short our dreams for the future of Canada and of the world is World War III. This possibility must always be in our minds, and we must never fail to do anything we can, no matter how small, to lessen the likelihood of war.

ONTARIO

Engineers in the News

J. Lorne Gray, vice-president of Atomic Energy of Canada Ltd., was guest speaker at the thirtieth Annual Meeting of the Canadian Standards Association in Ottawa on May 31. Mr. Gray spoke on "Recent Developments in Industrial Uses of Atomic Energy."

D. C. Alexander, has moved from Baltimore, Md., to Pasadena, Cal., and has accepted a position as development engineer with the Advanced Electronic Data Laboratory Division of the Consolidated Electrodynamic Corporation. While in Baltimore, he was employed as an assistant project engineer by Bendix Radio.

Frank A. Ross, has resigned from the staff of Amalgamated Electric Corporation Ltd., and has joined Canadian Allis-Chalmers Ltd., in St. Thomas, Ont.

has moved from Toronto to Ottawa, Ont., and is employed as a structural engineer in the building construction branch of the Department of Public Works of Canada.

William E. Field, who has been engaged in mining engineering in Boulder, Montana, has accepted the position of mine manager of National Explorations Ltd., at Uranium City, Sask.

Bruce D. Newman, of Toronto, has been promoted to the position of secretary of Barber-Greene Canada Ltd., Toronto. He is also chief engineer and assistant to the president of the company.

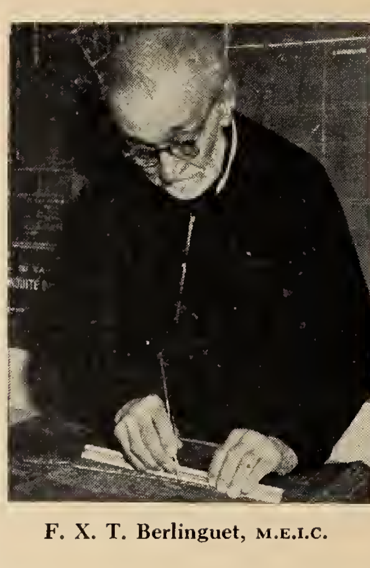
Mr. Newman is an engineering graduate of McGill University and joined Barber-Greene Canada Ltd. in 1952.

William R. Hood, has moved from Montreal to Corunna, Ont. where he is employed by the Ethyl Corporation of Canada Ltd., as an electrical and instrument engineer. Mr. Hood is a University of Toronto graduate in engineering and was with the engineering department of Bell Telephone Company of Canada at Montreal.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Francois Xavier Thomas Berlinguet, M.E.I.C., of Trois Rivieres, Que., oldest member of the Institute, who celebrated his one-hundreth and first birthday in 1956, died at Trois Rivières on May 15, 1957.



F. X. T. Berlinguet, M.E.I.C.

Born at Quebec, Que., on March 15, 1855, educated at Laval University, he studied civil engineering and land surveying and was graduated in 1876. He began his career as a contractor's draughtsman with the Intercolonial Railway. He was employed by the Federal Government on harbour work in Quebec and Trois Rivieres, becoming chief engineer of public works for the district. In the early days of his career he worked on the Quebec Harbour Survey in 1877; became an assistant engineer on the Lake St. John Railway in 1881; and the following year worked on the Trois Rivieres Harbour Survey, and the St. Lawrence River survey in 1883. Between 1884 and 1890 he was resident engineer for the St. Maurice River and Trois Rivieres Harbour.

After forty-six years of service with the department of Public Works he retired to private practice at Trois Rivières. He celebrated his seventieth year of professional practice and his ninety-first birthday in 1946, carrying on business as usual.

On the occasion of his one-hundredth birthday, in 1955, the Institute was represented at the ensuing festivities held by his family at Trois Rivieres by vice-president of the Institute, J. O. Martineau, of Quebec City. Mr. Berlinguet was able to participate in all parts of the program.

A Life Member of the Institute since 1931, Mr. Berlinguet joined as an Associate Member upon its foundation as the Canadian Society of Civil Engineers, in 1887, and was transferred to Member in 1890.

Andrew Edward Chalmers, M.E.I.C., city engineer at Peterborough since 1946, died on May 23, 1957, in that city.

Born at Cobourg, Ont., on December 18, 1899, Mr. Chalmers had his education at Queen's University and attained a B.Sc. degree in civil engineering in 1923. In his student years he worked during the summer months with the Toronto and York Roads Commission and the Department of Highways of Ontario. On graduation he accepted a position as resident engineer for the Smith Falls filter plant and in succeeding years to 1932 he was engineer for the districts of Crystal Beach, Bertie, and Welland County, and for the Town of Thorold, Ont.

In 1932 he accepted an appointment as engineer for the County of Peterborough. Joining the R.C.E., Canadian Army in 1940, he became a major in 1942 and returned to the City of Peterborough as assistant engineer in 1945.

Mr. Chalmers was president of the Canadian Institute on Sewage and Sanitation in 1953.

He joined the Institute as a Member in 1954.

Personals

News of the Personal Activities of Members of the Institute

R. W. Diamond, M.E.I.C., has been awarded the "Gold Medal" of The Institution of Mining and Metallurgy (London) for 1956. A year ago Mr. Diamond retired from the position of executive vice-president (Western Region) of The Consolidated Mining and Smelting Company of Canada Limited after thirty-nine years of continuous service with that company.

The Gold Medal was awarded to Mr. Diamond "in recognition of his distinguished services to the mineral industry in Canada".

He is a former president of The Canadian Institute of Mining and Metallurgy (1948-49). Currently he is President of the Sixth Commonwealth Mining and Metallurgical Congress which will be held in Canada this year. Approximately five hundred delegates to this Congress from about forty Commonwealth and other countries around the world will assemble in Vancouver on the 8th September next and from there will travel across Canada for thirty-two days visiting all of the principal mining and metallurgical centers, the oil fields of Alberta and the major cities of Canada. Closing sessions will be in Halifax on the 9th of October, 1957.

Charles E. Garnett, M.E.I.C., for many years president and managing director of Gorman's Limited, Edmonton, has been elected chairman of the Board and remains as director, relinquishing his managerial duties.

Mr. Garnett is also chairman of the Great Northern Gas Utilities Limited and Plains-Western Gas and Electric Limited, both of Edmonton and president of the Edmonton Elevator Service Limited. He is the director of Timber Preservers Limited, New Westminster, Consolidated Finance Company of Vancouver, Olympic Insurance Agents Limited of Vancouver, MacDonald Parking Limited of Edmonton, and a member of the Edmonton Board of the Royal Trust Company.

T. E. Bate, M.E.I.C., has been appointed president and managing director of Gorman's Limited, at Edmonton.

With Gorman's Limited, at Edmonton since 1948 he has held appointments with the firm as sales engineer, assistant manager, and manager of the Edmonton Elevator Service Company division of Gorman's Limited.

At one time Mr. Bate was employed with the Canadian National Railways as an assistant engineer.

Harrison S. Milne, M.E.I.C., was recently appointed by AMF Atomics (Canada) Limited as works manager of their new reactor fuel element manufacturing and development plant at Port Hope, Ont.

Mr. Milne graduated with a B.Sc. degree from the University of Saskatchewan in 1933 and returned in 1937-39 to study mechanical engineering.

In 1940 he joined Defense Industries Limited, engineering department, at Montreal, to work on shell plant layout and in 1941 was moved to small arms ammunition manufacturing at Verdun Works, where he remained until 1945. Transferred to the Chalk River Atomic Energy project he was resident engineer for D.I.L. during the construction of the N.R.X. reactor.

In 1947, when the National Research Council took over operation of the Atomic Energy project, Mr. Milne remained at Chalk River, as superintendent of mechanical and power services and in 1950 transferred to the newly formed Crown Corporation, Atomic Energy of Canada Limited, as superintendent of workshops and design. While at Chalk River he was in charge of fuel element production for the N.R.X. and N.R.U. nuclear reactors.

W. H. M. Laughlin, M.E.I.C.

H. S. Milne, M.E.I.C.

R. M. Robertson, M.E.I.C.

Robert M. Robertson, M.E.I.C., manager of operations for the Dominion Bridge Company Limited, Montreal, has been elected president of the Canadian Institute of Steel Construction Inc., at the organization's twenty-seventh annual general meeting held recently at Montebello, Que.

Mr. Robertson whose present appointment with Dominion Bridge dates to 1953, first joined the company in 1909.

In 1954 he was chosen by the Dominion government to direct Canada's $450,000,000 naval ship-building program.

W. H. M. Laughlin, M.E.I.C., for the past eleven years a member of the Toronto consulting engineering firm of Proctor, Redfern and Laughlin, now Proctor and Redfern, has announced the formation of the consulting firm of Laughlin, Wyllie and Ufnal. Both Mr. Laughlin's colleagues were formerly associated with him professionally over the last eleven years.

Carrying out the same fields of operation as previously the firm will be engaged in the planning, design and supervision of industrial plants, buildings, bridges and other diversified civil engineering work.

Mr. Laughlin's engineering career began with the Dominion Bridge Company Limited in 1928, a short time after his graduation from the University of Toronto in 1927. Holder of a B.A.Sc. degree at that time he later qualified for an M.A.Sc. degree and was awarded a C.E. at that university in 1938.

A structural designer and engineer with the firm for a number of years he was later appointed chief engineer for the Ontario division of the company.

In 1951 Mr. Laughlin was elected president of the Association of Professional Engineers of Ontario.

Always active in the Institute Mr. Laughlin has served in the capacities of chairman and councillor of the Toronto Branch.

Ernest Gohier, M.E.I.C., chief engineer of the Department of Roads of the province of Quebec, at Quebec City, for many years has retired from that post to become chairman of the Montreal-Laurentian Autoroute Board.

Mr. Gohier has been in private practice since 1914, shortly after his graduation from McGill University.

Over the years he has served as consulting engineer for the Montreal Metropolitan Commission, the Harbours of Quebec, Three Rivers and Chicoutimi and for several municipalities throughout the province of Quebec.

Dean R. M. Hardy, M.E.I.C., of the faculty of engineering, University of Alberta, received an honourary doctorate of science at the University of Manitoba convocation exercises held recently.

L. W. Pillar, M.E.I.C.

Dean of the faculty of engineering since 1948 he has been associated with the University of Alberta for many years in the civil and municipal engineering departments. He also had experience in the general engineering department of the Aluminum Company of Canada Limited, at Montreal.

In 1955 he was named a director of the Foundation of Canada Engineering Limited.

Dean Hardy was in 1949 elected president of the Association of Professional Engineers of Alberta.

Leslie W. Pillar, M.E.I.C., has joined De Leuw, Cather and Company of Canada Limited, consulting engineers of Toronto and Ottawa in the capacity of chief engineer.

Prior to joining De Leuw, Cather, Mr. Pillar was for three years director of planning and works for the City of Ottawa where he was responsible for a program of major highways, bridging and drainage schemes.

He brings to his new sphere of activity over twenty-five years' experience in civil and highway engineering schemes in England, Europe, the East, Africa and Canada. During World War II he served six years in the Royal Engineers.

Born in Essex, England, and educated at Christ's College and King's College, London, Mr. Pillar holds a diploma in civil engineering. He is a member of the Association of Professional Engineers of Ontario, and the American Society of Civil Engineers.

T. F. Hadwin, M.E.I.C., has been appointed district manager of the Bridge River area for the B.C. Electric Company Limited.

This area, with a present installed capacity of one 42,000 kva unit and four 50,000 kva units is being increased by the addition of one 22,000 kva unit and four 62,500 kva units to a total of 514,000 kva of hydro electric capacity.

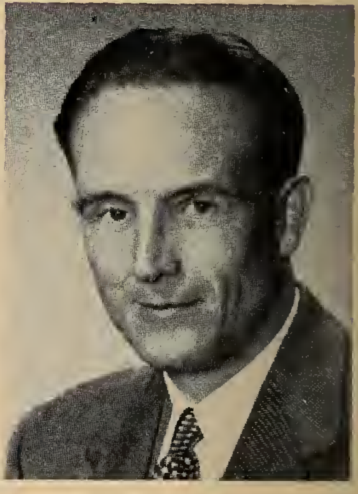
Mr. Hadwin is a graduate of the University of British Columbia with post-graduate training at the University of Pittsburgh. He has been active on the executive of the Vancouver Branch and on the Papers Committee for the 1957 annual meeting at Banff.

He was formerly superintendent of substations for the B.C. Electric Company Limited.

W. A. MacDonald, M.E.I.C., of Sydney, N.S., manager of the Seaboard Power Corporation Limited has been elected chairman of the Cape Breton Branch of the Institute.

Beginning his career with Northern Electric Company in 1929 at Montreal, he later went to the Provincial Highways Department of Nova Scotia. In 1934 he joined Dominion Steel and Coal Corporation at Sydney as an assistant to the

W. A. MacDonald, M.E.I.C.



T. F. Hadwin, M.E.I.C.

chief electrical engineer, carrying out field and construction work. He was appointed field engineer in 1942 and was associated with engineering and construction on the more recent units added to Seaboard's expanding facilities. The company supplies electrical energy for industrial and domestic purposes in Cape Breton.

Long interested in the activities of the Institute Mr. MacDonald represented the Cape Breton Branch of the E.I.C. as a councillor in 1948-49.

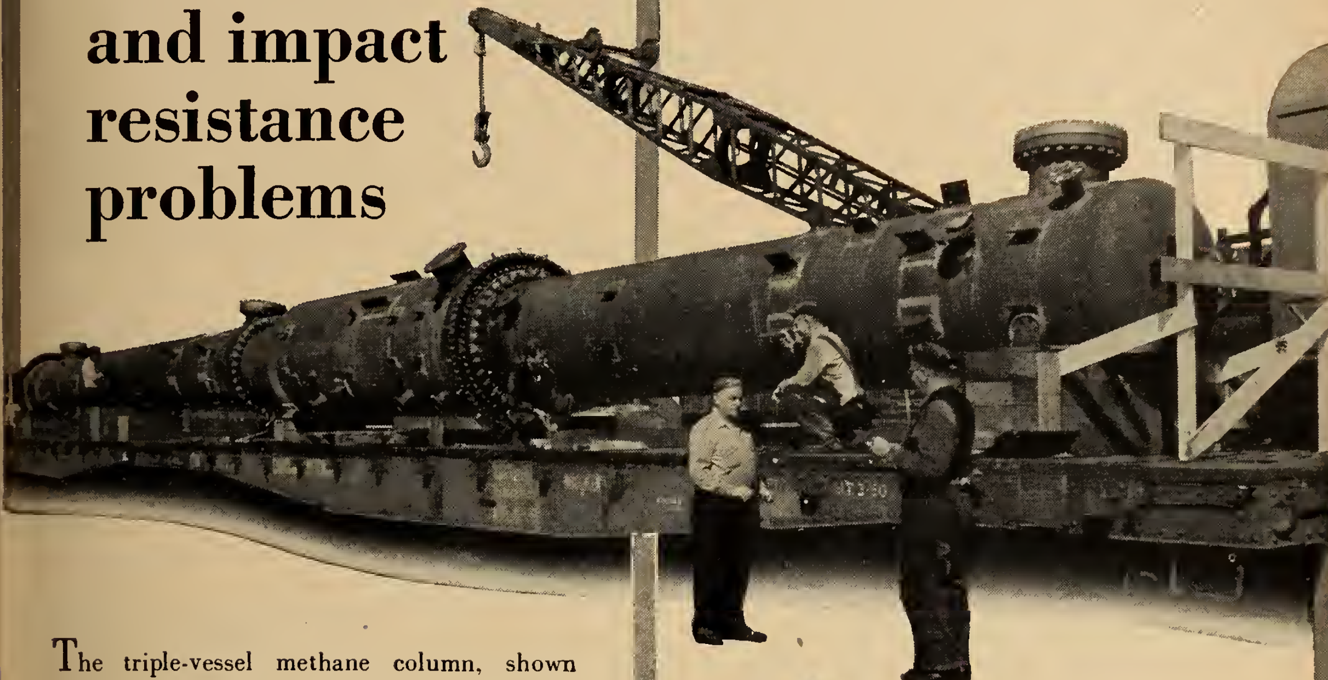
C. S. Landon, M.E.I.C., registrar of the Association of Professional Engineers was recently awarded an honourary doctorate of law at the University of Manitoba convocation exercises this spring.

Mr. Landon has been secretary and registrar of the Association for a number of years.

William L. Fraser, M.E.I.C., of the Hydro-Electric Power Commission of Ontario, has been named field project engineer for the Commission's St. Lawrence Power Project.

Formerly project manager for Ontario Hydro's Sir Adam Beck-Niagara No. 2

Solving corrosion and impact resistance problems



The triple-vessel methane column, shown above, was designed for an unusual combination of pressure and temperature conditions. It operates at a maximum working pressure of 300 psi with temperatures from plus 300°F to minus 238°F.

This vessel, of extra low carbon type 304 stainless steel, was especially designed and fabricated to resist corrosion at high temperatures and to provide impact resistance of welds and base material at low temperatures. Vessels for this type of service demand careful design, exacting control of fabricating processes and unexcelled welding skill.

The enlarged photograph, right, shows the finished appearance of the ground and polished weld contours which resulted in complete freedom from notches.

DOMINION BRIDGE COMPANY LIMITED

Plants: **MONTREAL • OTTAWA • TORONTO • WINNIPEG • CALGARY • VANCOUVER**
Assoc. Company Plants: **AMHERST, N.S.:** Robb Engineering Wks., Ltd. **QUEBEC:** Eastern Canada Steel & Iron Wks., Ltd. **SAULT STE. MARIE:** Sault Structural Steel Co. Ltd. **WINNIPEG:** Manitoba Bridge & Eng. Wks. Ltd. **CALGARY:** Riverside Iron & Eng. Wks., Ltd. **EDMONTON:** Standard Iron & Eng. Wks., Ltd.
Divisions: **Platework • Boiler • Structural • Mechanical • Warehouse**

Platework by Dominion Bridge

development, Mr. Fraser has also held the posts of project manager for Ontario Hydro's Chenaux development on the Ottawa River. Prior to that, during World War II, he was on the staff of the Department of National Defence, Naval Service and was district engineer on works and buildings along the Atlantic coast.

Mr. Fraser served with the Royal Canadian Engineers in World War I, and as a graduate of McGill University, shortly afterwards joined the staff of C. D. Howe and Company, consulting engineers at Port Arthur. Over the years he has maintained a number of important engineering posts, including that of resident engineer on highway construction for the Nova Scotia Department of Highways. He was a designing engineer for the Shawinigan Water and Power Company on hydro-electric power developments, and was resident engineer for the Nova Scotia Power Commission during the building of the Cowie Falls Development. He has also served as assistant chief engineer for the Nova Scotia Department of Highways and Public Works.

E. H. Peck, M.E.I.C.

William M. Hogg, M.E.I.C., formerly field project engineer of the Hydro-Electric Power Commission of Ontario, St. Lawrence Power development, has accepted an executive engineering position with the Great Lake Power Corporation Limited at Sault Ste. Marie, Ont. He will take charge of a new department of the Great Lake Power Corporation to be known as planning and development.

Mr. Hogg who has had extensive experience with Ontario Hydro has for ten years held the post of design engineer in the head office generation department. Appointed senior resident engineer at the Des Joachims development on the Ottawa River in 1949 he held the appointment of assistant field project engineer for the Sir Adam Beck Niagara No. 2 development, two years earlier. His appointment as field project engineer dates to 1954.

Mr. Hogg is a 1939 graduate of the University of Toronto.

John J. Miller, M.E.I.C., has been appointed general manager for Alumina, of the Ormet Corporation, situated at Burnside, Louisiana.

Mr. Miller who is a 1939 graduate of the University of Toronto was formerly assistant chief engineer of the Aluminum Company of Canada.

Adrian R. Leger, M.E.I.C., has been appointed general superintendent of operations with the Anglo-Newfoundland Development Company Limited at Grand Falls, Nfld.

Mr. Leger is a 1946 graduate of Laval University in chemical engineering, and was formerly control superintendent with the organization.

Esmond H. Peck, M.E.I.C., has received the appointment of manager of the Shawinigan Water and Power Company economic research department, at Montreal.

Associated with the firm since his 1936 graduation from McGill University Mr. Peck held an appointment in the firm's water resources and statistical depart-

. . . at C. S. F.

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Rigid inspection and strict adherence to quality control through every phase of manufacture is positive customer assurance that the finished product is right.

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Member: A. V. Roe Canada Limited and The Hawker Siddeley Group ment, for a number of years and was more recently assistant manager of the economics and statistics department of the company.

P. A. O'Connor, M.E.I.C., formerly Director of Works for the Canadian Army, holding the rank of lieutenant-colonel, has retired to civil life and has incorporated a company. President of the firm of P. A. O'Connor Company Limited, consultants and representatives, he is concerned with problems which arise out of contracts held by consulting engineers and architects and contractors with the government departments in Ottawa.

The firm deals with the interpretation of plans and specifications, discussions with owners, to arrive at design intent, submissions for certificates to the Inter-Service Equivalents Board and various other matters which arise out of engineering and construction contracts.

J. Maurice Macé, M.E.I.C., has been appointed Quebec regional manager of the sales division of Northern Electric Company Limited.

Mr. Macé is a graduate of McGill University in electrical engineering, and has been with Northern Electric since 1938 when he joined the power apparatus sales department in Montreal.

J. M. Macé, M.E.I.C.

For a period during World War he was a sales engineer for mari power and degaussing equipment. Afi a year in the rural electrification depa ment, he was appointed manager Quebec house in 1947.

In 1949 Mr. Macé was appointed ma ager of the rural electrification a power company sales, in 1951 manag of wire and cable sales, eastern distri he became in 1955 assistant district sa manager. (Eastern.)

Major Malcolm Turner, M.E.I.C., l been promoted to the rank of acti lieutenant-colonel. The appointment w be effective August 15, 1957. He was the same time named commander of Works Company, Royal Canadian En neers, at Vancouver, and area engin officer of the British Columbia area.

Major Turner now holds the respo sibility of second-in-command, first fi engineer regiment, at Camp Chilliwa B.C.

He is a graduate of the Royal Milit College, Kingston, 1939, and also graduate of Queen's University, class 1947 in civil engineering. Major Turn spent a year in the United Kingdom the R.C.E. Staff College in Camber in 1954.

Joseph A. D'Angelo, M.E.I.C., has b named budget manager of the eng division of the Chrysler Corporation, I troit, Michigan.

He was formerly associated with Ford Motor Company of Canada budget supervisor of the machine sl and stamping plant in the Wind manufacturing division.

He is a University of Manitoba gr uate in electrical engineering, class 1946 and also holds a bachelor of co merce degree from that university.

D. D. Dick, M.E.I.C., has resigned fr the staff of the North Western Pulp Power Limited, Hinton, Alta., to t up a position in Montreal. In his n capacity he will serve as chief civil en neer with the Power Corporation of C ada Limited.

Earlier in his career Mr. Dick gained experience with the B.C. International Engineering Company, and H. A. Simons Company, both of Vancouver, and with the firm of McMillan and Bloedel, Harmac pulp division, Nanaimo, B.C.

T. G. Anglin, M.E.I.C., consulting engineer of T. G. Anglin Engineering Company Limited, Montreal has moved from the Dominion Square Building where he has practised for the past ten years, to his company's own office building at 4294 St. Catherine Street West, Montreal.

L. H. Harper, JR.E.I.C., a 1951 graduate of Queen's University in civil engineering is engaged as a project engineer with Defence Construction (1951) Limited, at the R.C.A.F. Station, Rockcliffe, Ont.

With Gore and Storrie Limited from 1951 to 1955, he later joined Algoma Uranium Mines at Elliott Lake, Ont. as an assistant construction engineer. In 1956 he became employed by Defence Construction Limited, Camp Borden, Ont. as an assistant project engineer, and was later transferred to the R.C.A.F. Station, Uplands, Ont., in the same capacity. His present duties involve additional work at Shirley Bay and Connaught Ranges.

C. J. Konzuk, JR.E.I.C., has lately been promoted to manager of the operations division with Canadian Aviation Electronics at their main plant in Montreal.

Mr. Konzuk who is a graduate of McGill University, in electrical engineering and was a wartime radar officer in Canada and overseas. He has been with C.A.E. since 1951. He has progressively filled the posts of manager of the repair and overhaul and the electronics maintenance and manufacturing departments.

C. J. Konzuk, JR.E.I.C.

W. A. Doby, JR.E.I.C., University of Manitoba, class of 1951, and later sales engineer with the Canadian Westinghouse Company Limited, is presently employed with the Los Angeles, Calif., consulting engineering firm of Ralph M. Parsons Company. He is an electrical design engineer in the architect-engineering division of the organization which is prominent in the oil manufacturing design and rocket and missile launching devices and control.

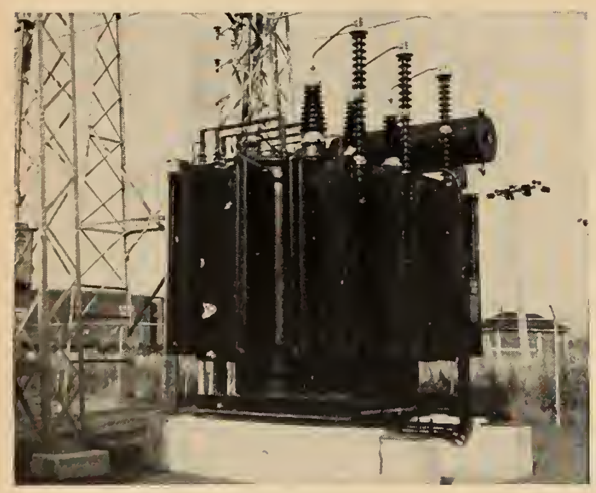
L. L. Anderson, JR.E.I.C., of the Department of Mines and Technical Surveys, at Ottawa, has been promoted to the post of chief of the legal surveys section, legal surveys and aeronautical charts division of the Department.

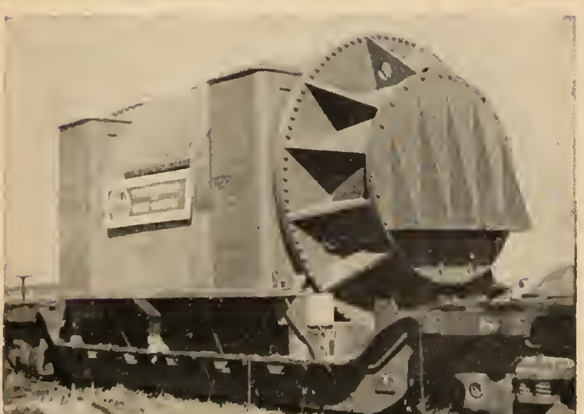
Mr. Anderson was first employed as a surveyor and engineer in the government department. He is a B.A.Sc. graduate in civil engineering of the University of Toronto, class of 1950.

W. D. Parsons, JR.E.I.C., has been recently appointed assistant plant engineer with the Cerro de Pasco Corporation in Peru. The Cerro de Pasco Corporation is one of the world's largest producers of copper, lead and zinc located in La Oroya, high in the central Peruvian Andes.

Mr. Parsons joined the Corporation in

If power is your responsibility



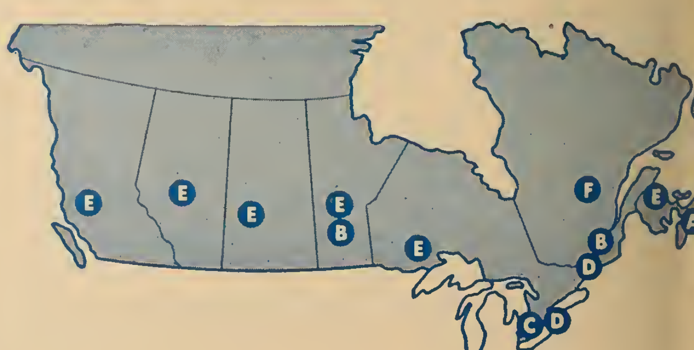


A DISTRIBUTION TRANSFORMERS

The "BB-99" Distribution Transformer was designed by Brown Boveri to meet the standards of the Canadian utility. BB-99 installations like this one in Halifax, N.S. have been service-proved from coast-to-coast.

B POWER TRANSFORMERS

Industries and utilities across Canada are being dependably served by Brown Boveri transformers like this 10,000 KVA 66,000/4160 volt type ONS unit, supplied to Quebec Power Co. Limited.



C SYNCHRONOUS CONDENSERS

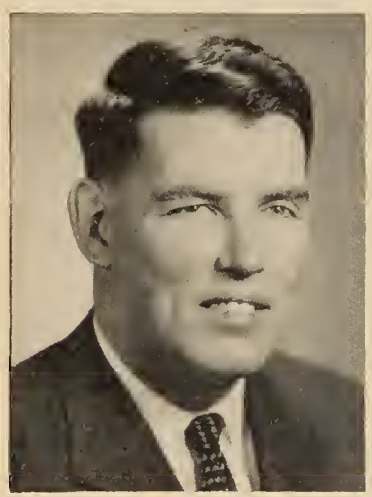
This 48,000 KVA 13,800 volt, 900 rpm hydrogen-cooled equipment in transit to Hydro Electric Power Commission of Ontario is typical of the many types of heavy duty rotating machinery built by Brown Boveri.

December 1955 as mechanical engineer and staff engineer. He was previously employed as mechanical superintendent in the Colombian operation of South American Gold and Platinum Company.

Mr. Parsons is a 1952 graduate from McGill University.

P. J. Tansey, JR.E.I.C., has been appointed manager of the asphalt department, eastern division, Shell Oil Company of Canada Limited. He will be responsible for asphalt sales within the eastern division marketing area, with offices in the Shell Tower Building, Montreal.

A McGill University graduate, class of 1948 Mr. Tansey has spent a number of years with the Shell Oil Company of Canada Limited, serving as a sales engineer at Ottawa and Montreal. In 1955 he was the St. Lawrence Seaway representative for the Shell company.



P. J. Tansey, JR.E.I.C.

J. R. Marchand, JR.E.I.C., formerly a flying officer with the R.C.A.F., 408 (P) Sqn., at Rockcliffe, Ont., has returned to civilian life and has accepted a position with the Manitoba Telephone System at Winnipeg.

A 1954 graduate of the University of Manitoba in electrical engineering Mr. Marchand has previously been employed with the R.C.A.F. as Shoran Telecommunications Officer for 408 (photo) squadron and was involved in the Shoran Survey of northern Quebec, the Yukon, and the Arctic Islands. Shoran, a contraction of the words, "short range navigation", is an electronic method of measuring distances, utilizing a network of ground radar stations operating in conjunction with airborne radar equipment.

W. R. Badun, JR.E.I.C., who was this year awarded a master's degree in business administration at the University of Western Ontario, has accepted an appointment with Super Motor and Electric Limited at Kitchener. He will serve the company in an executive capacity.

Mr. Badun graduated from the University of Alberta in 1952 in electrical engineering and then worked for two years with H. H. Angus and Associates, as field supervisor of electrical and mechanical construction.

At a later date he worked with the Aluminum Company of Canada as assistant electrical supervisor on plant maintenance and construction.

George S. Bowes, JR.E.I.C., University of Toronto, 1949, who formerly held a position with the Brantford Roofing Company Limited at Thorold, Ont., has been appointed a technical director of the No-Co-Rode Company Limited, a subsidiary of Dominion Tar and Chemical Company Limited, at Cornwall, Ont.

L. R. Broderick, S.E.I.C., a University of Toronto graduate, class of 1957, in civil engineering holds an appointment as assistant project engineer with the Greater Vancouver Water District.

NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

EDMONTON

G. HODGE, M.E.I.C.,
Secretary-treasurer

S. R. SINCLAIR, M.E.I.C.,
Branch News Reporter

Active Season

The past season, dating from the last annual meeting in April 1956, has been an extremely active one for the Edmonton Branch. A total of twelve meetings have been held, covering the field of engineering activity very thoroughly. In May a talk on "Reservoir Engineering" was delivered by Prof. J. W. Gregg of the University of Alberta and an annual meeting picnic held in June. Getting underway again in September, "Trends in cable Insulations", and a Dew Line Film by W. J. Pardy of Northern Electric Company, followed by "What's Ahead in Lighting", by J. W. Bateman of the Canadian General Electric Company were enjoyed. The Annual Engineers banquet and dance marked the visit of President McKillop in November. In January "High Temperature Reaction Systems", by Dr. D. Quon, of the Research Council of Alberta, and "Edmonton's New Sewage Treatment Plant", by Commissioner D. B. Menzies was heard. The February meeting took the form of the annual smoker. In March, "Light Weight Aggregates" by L. S. Thorssen of Consolidated Concrete Industries Limited and "Air Conditioning", by G. Greenwood of Cumming Galbraith Limited were heard. Closing the program Sir Claude Gibb of Great Britain delivered an address on "Nuclear Generation", followed by the Annual Meeting and tour of the Northwest Industries.

In addition, arrangements had been made for a tour of the Hinton pulp and paper plant. Unfortunately, the opening of the plant has been delayed and the proposed tour was postponed until October 1957.

While attendance at the social functions was good, representation at the technical and general meetings was far below expectation. Out of a membership of 727, attendance averaged 63 persons per meeting.

Attendance at the branch meetings has indicated that the membership will turn out in large numbers for "project" type talks such as that presented by Commissioner D. B. Menzies on Edmonton's sewerage treatment facilities. Attendance at the more specialized talks indicates that the idea of technical divisions presently under consideration at headquarters is probably the best answer to maintain the interest of engineers in the Institute.

The annual ball at the Macdonald Hotel was again a great success, 328 attending. The visit of president V. A. McKillop was very pleasant and marked the first time such an event has been filmed and presented on TV in Edmonton.

Annual Meeting

On April 17, 1957, the members of the Edmonton Branch were the guests of Northwest Industries Limited. There were approximately 125 members present.

After a delicious dinner, prepared and served in the plant cafeteria, B. W. Pitfield, vice-president and general manager of Northwest Industries Limited, welcomed the members and gave a brief talk on the role of his company in the aviation industry.

Northwest Industries has approximately 900 employees, and is the largest Canadian-owned aircraft repair company. The company is equipped to work on all types of commercial aircraft, although the major part of its work is for the R.C.A.F.

Mr. Pitfield's talk was followed by an interesting tour of the plant, during which the members saw various types of aircraft, both civil and military, under repair. For those members who were not familiar with the operations at this plant, the tour brought out the important contribution which Northwest Industries Limited is making to both civil and military aviation in Western Canada.

The Branch annual meeting was held in the plant cafeteria following the tour.

Arrangements for the evening were made by R. H. Gardener, planning and control manager of Northwest Industries Limited.

LONDON

Wives' Association

Steps toward organization of an Engineers' Wives Association in London, Ont., took place on May 23, 1957, with the formation of an informal executive.

Mrs. D. J. Matthews, wife of the chairman, invited the following ladies to luncheon: Mrs. V. A. McKillop, wife of the president of the Institute, Mrs. L. Stuart Lauchland, Mrs. D. M. Jenkins, Mrs. C. H. Osborne, Mrs. H. R. Hayman, Mrs. H. E. Martin, and Mrs. R. W. McMeekin, to hear Mrs. Lilian Robertson of the Field Office, Toronto, speak on the activities of the Wives' Associations and on the proposed discussion in Banff regarding a national organization.

The group was most interested, especially in the idea that a purely social group be formed, which would probably hold two social gatherings a year, with very small membership fee; and particularly welcome newcomers among engineers' wives who move to London.

Mrs. McKillop offered her home for a coffee party or afternoon tea in the fall, which would be the first general meeting to which the wives of all E.I.C. members would be invited. In the meantime the others who were at luncheon will form an informal committee to divide the branch list into telephone sections, and meet early in June to discuss further plans.

NEWFOUNDLAND

C. W. HENRY, M.E.I.C.,
Secretary

SUCCESSFUL YEAR

The Newfoundland Branch has had a successful year to date.

The first meeting of the year was held October 19, 1956. This was a business meeting and a number of topics of interest to the Branch were discussed. Chief among these was the possibility of sponsoring the introduction of C.S.A. Standards to Newfoundland on a provincial basis. It was decided that the Branch Secretary should write C.S.A. to see if practical help might be obtained.

A. M. Fraser, M.P. Speaker

A. M. Fraser M.P. addressed the next meeting on November 12, 1956. Mr Fraser was professor of economics and political science at Memorial University for 25 years before his election to Parliament. He described the background and

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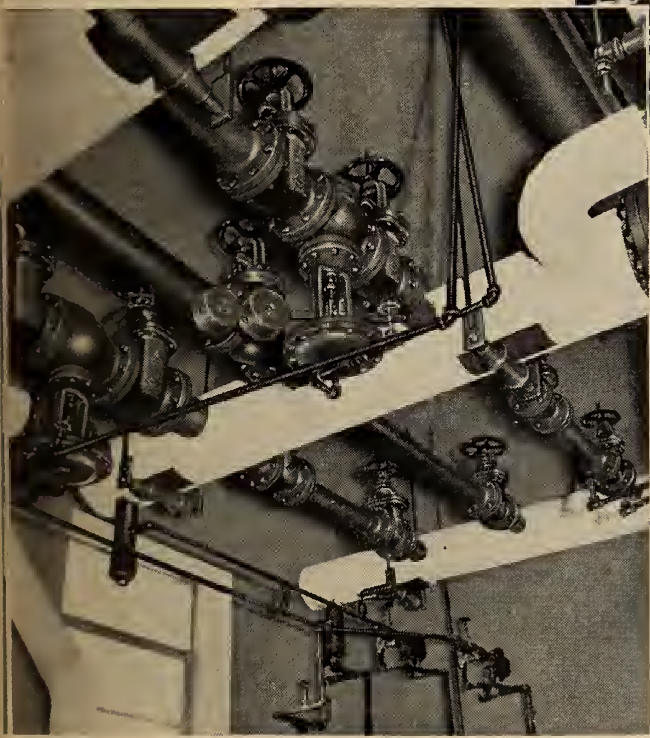

Edmonton's new 10-story Federal Building typifies the city's growing stature as one of the world's leading oil capitals. Scheduled to open in January, 1958, the massive building will house every federal department except the Post Office and the Unemployment Insurance Commission. Reliable Jenkins valves have been installed by the contractors to direct and control the flow of heat for the $6,000,000 building. For unsurpassed efficiency, long life, and trouble-free maintenance, *it pays to deal with specialists.* When specifications call for valves, call Jenkins.

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personalities involved in the Middle East situation in a most interesting way. His talk was followed by a question and discussion period. Those attending felt that Mr. Fraser had given a very lucid account of causes and possible affects of present troubles in the Middle East.

It had been intended to hold the December meeting at Bell Island and to include a tour of the iron ore mine as part of this program. Unfortunately this trip had to be put off until later, due to last minute difficulties. A program of films was arranged instead and a film on Atomic Energy was given.

Deputy Minister of Mines is Guest

At the January meeting, Fred Gover, Deputy Minister of Mines for Newfoundland, discussed "Exploration by Concession". He explained the Provincial Government's policy of arranging for mineral exploration by private companies in areas in which they had been granted an exclusive right to search for, and develop mineral deposits covered by their concession agreements within the time stipulated in the agreement. Mr. Gover then discussed the factors which determine the feasibility of developing a mineral discovery and concluded by describing the results of the concession system in Newfoundland.

Railway Problems Outlined

At the February meeting, E. J. Cooke, manager of the C.N.R. Newfoundland district, outlined some of the basic problems with which his company has had to contend since taking over rail and coastal steamship services in Newfoundland in 1949. Mr. Cooke said that in many ways the Newfoundland operations were unique in Canada and required special techniques in railroading, however, the extension and modernization of facilities and equipment should result in an adequate and satisfactory transportation service. Mr. Cooke then described some recently completed improvements and some which are planned for the future.

Students' Night

The 5th annual "Students' Night" program was featured at the March meeting held March 11th, 1957. The Students' Night program is the culmination of the public speaking seminar conducted by Dean Carew with the engineering students at Memorial University. During the course of this seminar the engineering students are given practical training in the techniques of public speaking and at the end of this series, the three best speakers are chosen to compete for a prize of $50.00 offered by the Newfoundland Branch of the Institute.

Chairman V. A. Ainsworth, M.E.I.C., was in the chair and the following speakers were introduced by Dean S. S. Carew, M.E.I.C., E. Dunne, who spoke on The Quebec Bridge, A. Knight, who chose Flash Bulbs, and D. Noble whose subject was Guided Missiles.

The winner will be announced and the prize presented at the annual meeting of the Branch in May.

Programs planned for the balance of the year were, on April 8, "Power and Passage", a film prepared for Canadian General Electric Company about the St. Lawrence Seaway; the Annual Dance on April 25 and the Annual Dinner Meeting, May 13.

PETERBOROUGH

V. AARE, M.E.I.C.,
Publicity Chairman

Annual Students' Night

Live oysters and a review of the engineering profession was the fare served to student engineers at the Students Night held March 21.

A special invitation was sent out to branch student members and to the student engineers attending the test course at the Canadian General Electric plant in Peterborough. Students of the C.G.E.'s professional development course, preparing for Professional Engineer examinations were also invited.

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Structure is reinforced throughout with 500 tons of Burlington Rail Steel reinforcing.

Designed for convenience, the new Municipal Parking garage in downtown Toronto is another stride toward the solution to an acute problem. Situated at Queen and Victoria Streets, this new five level structure of reinforced concrete provides the ultimate in parking ease for 500 cars.

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• BRANCH NEWS

The objective of the meeting was to discuss aspects of the engineering profession with student engineers and inform them about the work done for the profession by the Engineering Institute of Canada and the Association of Professional Engineers of Ontario.

The evening started with a film followed by a panel discussion on the subject "The Engineering Profession". Panel members agreed that the primary responsibility of an engineer is to provide the public and his employer with high quality technical service. The engineering organizations are very valuable help to the individual engineer in promoting the exchange of technical information, issuing a code of ethics, etc.

In the panel discussion Albert J. Bonney, counsellor for Peterborough area, P. W. Doddridge, J. F. Howard, R. H. Stuart, participated, as well as students J. G. Pearsall and B. Ahearn, moderator.

As guest speakers T. C. Keefer, field secretary of A.P.E.O. and D. D. Whitson, counsellor of the E.I.C., Toronto area, represented the two main engineering organizations.

Mr. Keefer explained the role of A.P.E.O. as the legalizing body of professional engineers in Ontario.

Mr. Whitson stressed the importance of E.I.C. as the nationwide Canadian engineering organization with the aims of promoting exchange of technical information through meetings, technical papers and the Engineering Journal.

W. H. Ackhurst, chairman of the meeting also demonstrated the technique of opening the oysters to the student engineers.

New Community Centre Discussed

Design features of the new Peterborough Memorial Community Centre were discussed at a Branch meeting held at the Centre April 10.

The million-dollar Centre is the biggest community building project of the past decade in Peterborough and was officially opened by Governor-General

ANNUAL GOLF TOURNAMENT

MONTREAL BRANCH

Junior and Senior Sections

It is suggested that foursomes be made up of two senior and two junior members.

Golf will be followed by an informal dinner

DATE: **Saturday, September 7**

PLACE: **St. Hyacinthe Golf Club**

• BRANCH NEWS

Massey in November, 1956.

Three Speakers. The speakers on the symposium were James S. Craig, architect, Peterborough, G. R. Williams, structural engineer from Wallace Carruthers & Assn., Toronto, and C. E. Beynon, mechanical engineer from McGregor & Beynon, Toronto. These men were the main designers of the Memorial Centre.

Mr. Craig explained the extreme flexibility in use of the main auditorium. When mainly used as a hockey arena, the ice can be covered with an extra floor in a very short time to convert the auditorium into a concert-hall.

The main ice floor is of unique design, different from and superior to others, because the concrete slab does not rest directly on the ground but has an air space between. This type of design prevents frost heaving of the ground underneath and permits quicker defrosting.

The structural design uses basically only four trusses to carry the weight of the whole building and leave the main floor free of obstructing columns.

An inspection tour, conducted by the speakers, was made through the building.

In connection with the new Memorial Centre, it is interesting to note the importance of E.I.C. members in the Peterborough community planning. Alderman Ross Dobbin, past-president of E.I.C. was chairman of the building committee for the Memorial Centre. H. R. Sills, vice-president, is a past-chairman of the City Planning Board and A. L. Malby, is at present chairman of the Board.

Wives' Association

The Wives' Association of the Peterborough Branch was formed at a meeting held on May 8, when Mrs. H. R. Sills invited the wives of fifteen E.I.C. senior members and executives to a coffee party at her home. This group decided to hold the first general meeting on May 29 at the Kawartha Golf and Country Club, starting at 8 p.m., followed by supper, and to invite Mrs. Lilian Robertson of the Field Office in Toronto, to describe the various engineers' wives' groups now organized, and the plan for a national organization.

The group telephoned all the E.I.C. wives in the branch and invited them to attend. They were very pleased to have 65 at the meeting, and all wished to become members of the new association immediately.

It was decided to hold four general meetings a year. Four social groups, such as a book exchange, crafts, bowling and bridge would be included.

Mrs. Sills was chairman of the meeting and Mrs. B. G. Ahern acted as secretary. The following will meet during the summer to draw up a slate of officers and complete arrangements for the official opening meeting in September: Mrs. H. R. Sills, Mrs. B. G. Ahern, Mrs. P. F. Peele, Mrs. B. L. Barnes, Mrs. P. W. Doddridge, Mrs. J. G. Pearsall, Mrs. A. Bonney, Mrs. W. H Ackhurst, Mrs. I. N. MacKay, Mrs. D. B. Chase, Mrs. R. Bergey, Mrs. M. Uloth and Mrs. F. R. Pope.

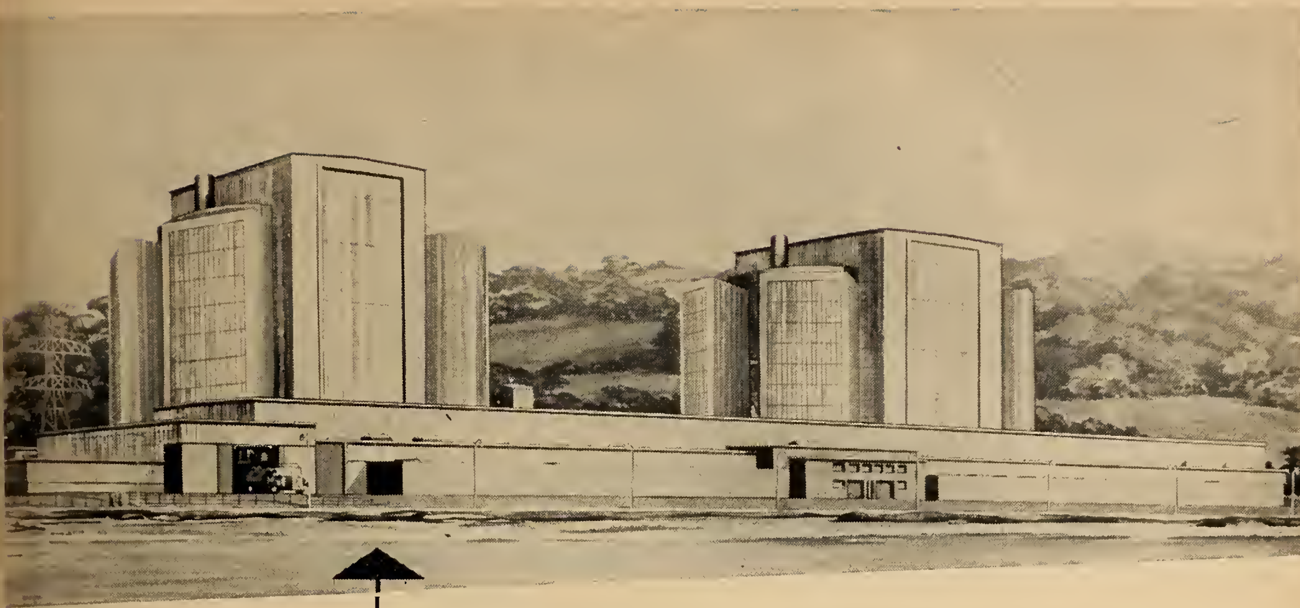
Niagara Falls Tour

Members of the Peterborough Branch visited Niagara Falls last Saturday for a tour through the remedial works area and power plants. Guided by Ontario Hydro's public relation man, the engineers first toured the control dam above the falls. The dam, which nears its completion has 13 control gates and is the main part of the remedial works for preservation of the Falls.

Second stop was made at the new pumping-storage plant in Queenston. This pumping-generating station, which is under construction, will pump with its six 55000 h.p. pump-motor units extra water, available during the night, into a 750 acres reservoir. The water will be used to generate electricity in the same turbine-generator sets during peak load periods in daytime.

This pumping station is one of the first of its kind in North America featuring turbines of unit design.

Finally Sir Adam Beck Generating Station No. 2 containing sixteen 8050(kva. generators were inspected. H. R·



• BRANCH NEWS

Sills from Peterborough who was among the visiting engineers, has designed the generators for this power station.

TORONTO

D. S. MOYER, JR.E.I.C.,
Secretary-treasurer

A. C. DAVIDSON, M.E.I.C.,
Branch News Editor

Operations Research

About 60 members heard a well delivered talk on "The Engineer and Operations Research", on March 14, given by Dr. Peter J. Sandiford, director of operations research, Price Waterhouse Company. Developing his talk on informal lines, he held the interest of the audience for nearly two hours.

Dr. Sandiford was introduced by Morgan H. Pryce, who was in charge of meeting arrangements. Before joining Price Waterhouse, Dr. Sandiford was chairman of the operations research group of the Ontario-Hydro. He is vice-president of the Canadian Association of Physicists, and a past president of the Operations Research Society of Toronto.

He began by inviting the audience to choose some specific topic in operations research on which he might speak. As few had experience in this realm, the audience was considerably puzzled. Such an approach emphasized forcefully the nebulous nature of the subject, in fact, no one has produced a good definition so far. The application of OR, as it is called in industry, speaks for itself.

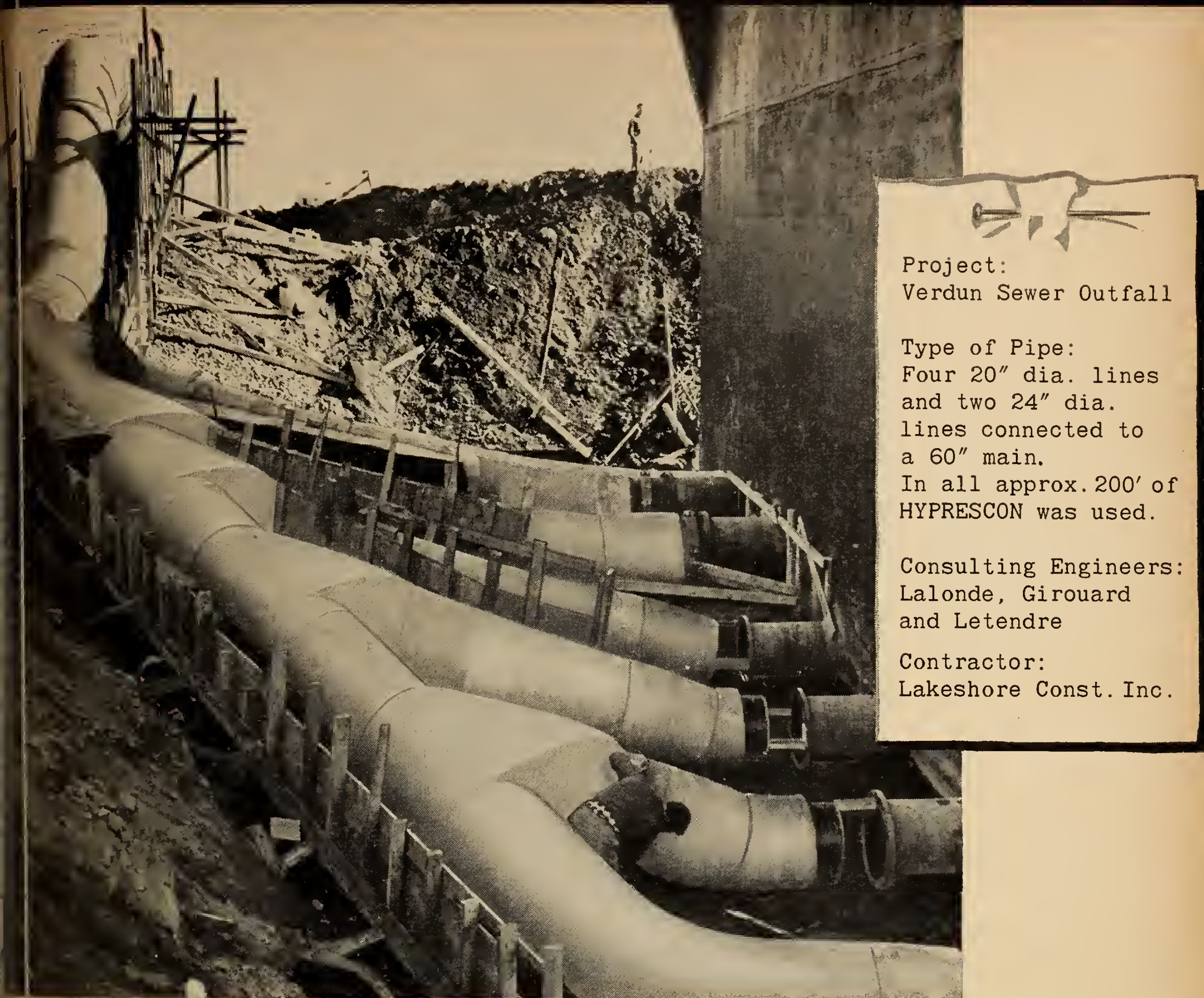
Three Main Groupings — The application may be broken down into three main groups: personnel, technique and organization.

The Personnel are scientists "Take a savvy boy and give him a job to do". who are interested in business, able to read mathematics, and who are clear thinkers. An OR team may consist of two engineers and one mathematician. The successful teams usually contain engineers (of the honest variety) and consequently OR is a good field for them.

The techniques involved are principally mathematical. Algebra, mathematical statistics, calculus, the calculus of variations, and probability theory are the most commonly used. Linear programming, another technique very dear to the heart of an OR man, involves the use of queue theory, the monte carlo method, statistical theory, and the theory of games. The fields where these techniques burgeon are: inventory control, production scheduling, capital equipment replacement budgeting, and lastly, forecast and planning. The first two applications are receiving the most atten tion at the present time.

Organizational Chart — Dr. Sandiforc then proceeded to demolish the audi ence's inhibitions with some fun anc games on an organizational chart, o from machine operator to president i six crazy stages and back again. Th clashes between problems and person alities at various stages and levels bring in the OR men on the run. In this char at the upper level, grand strategy mus be employed. How capital should be allo cated, and whether a new field of en deavor should be entered by the firr are a couple of sample problems at th level. Strategy of the following kind de velops between the high level and th next lower: What should the replace ment policy be? How should a natur resource be developed? What is the be inventory policy? How should the en trances and exits be placed on that ne super highway?

Tactics Level — At the tactics lev questions like these arise: How shoul the product be shipped to produce minimum freight bill? How should pr duction be scheduled to minimize lo in the product? How should gasoline b blended for the most profit? What a the re-order points and the amounts l in an inventory control program? Ho long should delinquent accounts be pu



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sued? How should aircraft be stacked over an airport?

Where do these three divisions fit into the operations of a business? Where does one stop and the other start? It is hard to say. Tactics might be looked on as a combination of industrial engineering and mathematics. Grand strategy could be a combination of economics and mathematics, and strategy lie somewhere in between. Take your choice — now it can be seen why it is so hard to pin down OR with a definition.

The process of education in OR is to read for one's self. Dr. Sandiford said that he could only stimulate interest and direit attention to books.

OR as a Career — If anyone is seduced by the siren call to drop everything else and take up OR, he must remember that it is nearly impossible to leave again. The transmigrator stops being a technical specialist and becomes a business generalist. The transition is fast, and may be very shocking to the man who makes the change.

In the question period which followed, Dr. Sandiford made many important points, among them the fact that stating the problem correctly at the beginning is the first step in solving it, and just as important, is the payoff worth the cost of doing the problem? Fees for such service run at current consulting rates.

Several examples of the application or mis-application of linear programming were also given.

Sir Claude Gibb

Between five and five hundred and fifty members and guests heard Sir Claude Gibb, the chairman and managing director of C. A. Parsons Limited, talk on nuclear power generation developments in Britain. Sir Claude was introduced by A. W. Manby, general manager of the Ontario Hydro Electric Power Commission. Mr. Manby told of Sir Claude's many scientific and commercial interests, and the honours which have been bestowed on him for his services to Britain.

Sir Claude himself stated that he would deliver the paper which he had given before the Institution of Mechanical Engineers in Great Britain on the subject of "Engineering Problems in the Development of Nuclear Power". This paper was given at the request of the Institution and is known as the Thomas Hawkesley Lecture, and is one of the events in the Institution's year.

Nuclear Power For Survival. Due to Middle Eastern events and division among the great powers, Britain must develop nuclear energy sources in order to survive. Electrical power is the easiest to use, and the nation with the highest consumption of electricity per head has the highest standard of living. The greatest factor in increased production is the increase in the use of electric power. Even though the consumption of coal per kw. generated was reduced, and the production of coal increased, Britain must consider other sources of energy. Oil for power generation was ruled out for obvious reasons, and gas was not obtainable. If oil became a vital part of the power picture, Britain might have to fight for it. A more peaceable way must be sought if Britain was to maintain her position in the brotherhood of nations.

Contingent on Scientist, Engineer. The future then, depends on the scientist and the engineer, with the scientist developing and the engineer applying the knowledge found. Calder Hall was an intuitive guess bordering on genius. After considering all the possibilities and their economic significance as far as Britain was concerned, it was finally settled that the uranium-graphite moderator-carbon dioxide transfer medium was the best, and most reliable. Sir Claude claimed that Calder Hall, the first operating nuclear power plant is a "model

which is the envy of the world". The overriding requirement of safety governs the philosophy of design. The reliability of the operation and high availablity of supply come next. Siting of the plant depends on the attitude of the population. With these factors in mind, detail development of the plant can be considered. Many possibilities were considered in the Calder Hall design, but it was really nothing more or less than the old and tried method of trial design repeated many times.

Sir Claude described many of the intimate details which were worked out as the design progressed and the urgent problems which had to be solved.

In the question period which followed Sir Claude brought out a number of interesting points. The cost of power based on a 5 per cent write-off and a 20-year life with uranium at today's cost, in a 400 mw. plant is about 7 mills per kwh. Ordinary commercial contracts are now possible.

To avoid corrosion from carbon dioxide, the gas must be dry. So far no corrosion has been experienced at the operating temperature range.

The nuclear power plant is a base load plant running as close to 100 per cent capacity as possible. No shut-down or start-up should be made in the operation if this can be avoided. Brittle irradiated steel should remain at constant pressure and temperature. Problems of stress in the structure are minimized under constants operating conditions. The present requirement of the Board of Trade that a thorough inspection of every pressure vessel be made each 14 months should be raised to 5 or 6 years at least.

A pinhole in a rod sheath to be visible to the eye must run for at least 72 hours. A burst slug can be found quickly and on full load.

Two important cardinal rules should be followed: Don't put anything into the reactor which may become radioactive if it has to be removed at a later date. Don't use an auxiliary fuel for superheater firing, as two different kinds of operator will be needed.

The thanks of the meeting were tendered by V. A. McKillop who suggested that nuclear power be studied by all serious-minded engineers.

Wives' Association

A group of twenty-seven wives of executive members, past and present, met at the home of Mrs. K. F. Tupper on March 28 to discuss the formation of an Engineering Institute wives group in Toronto. The meeting was unanimously in favour of this. It was decided to send out invitations to the wives of all members and juniors to attend a coffee party on May 15, from 1.30 to 3 p.m., at the North Toronto Memorial Gardens, when they would be invited to join a group.

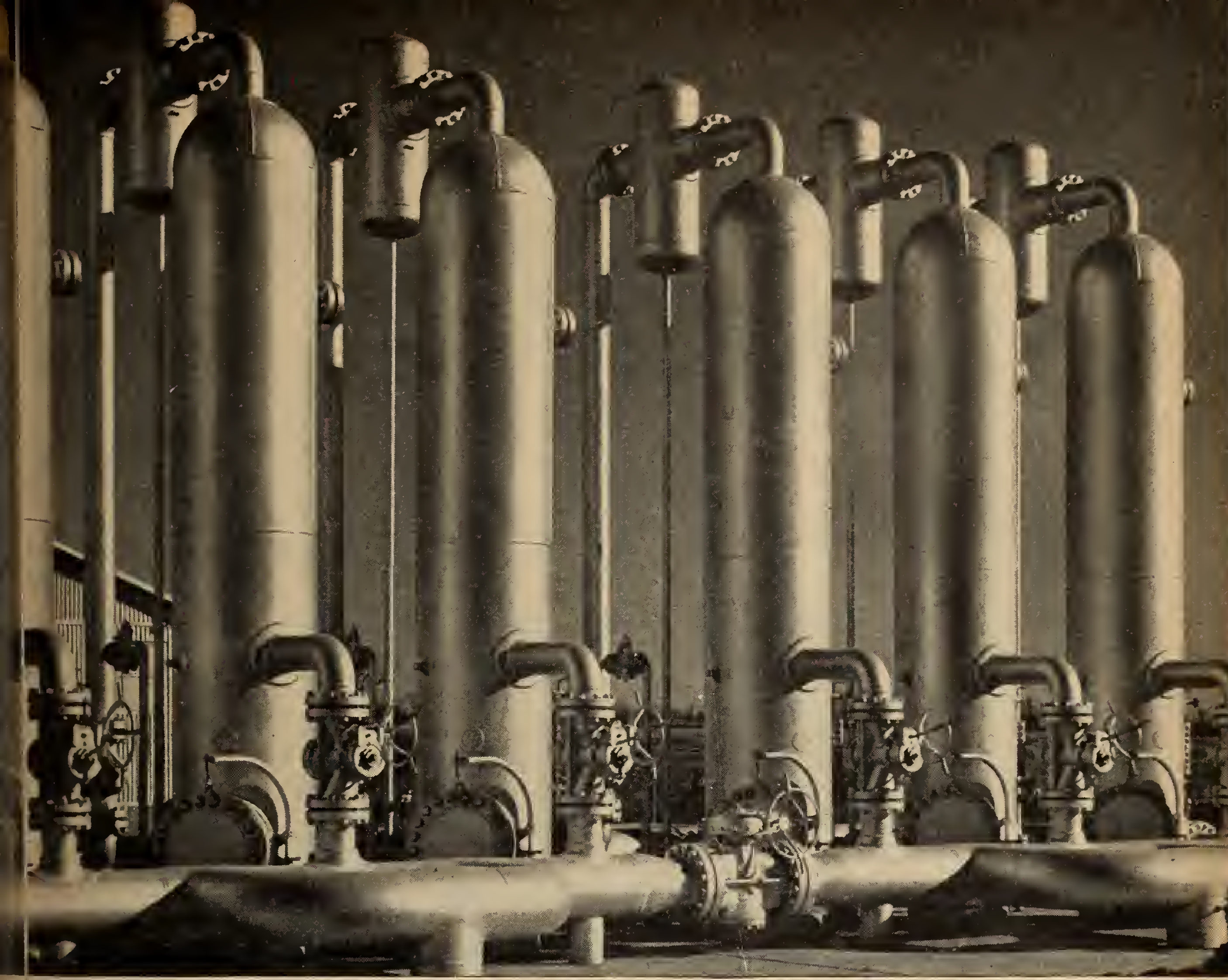
Despite rainy weather, more than 220 ladies attended the party, and 137 registered as being interested in joining. It is, therefore, felt that the E.I.C. Toronto Wives' Association is now established

Mrs. D. D. Whitson, Mrs. K. F. Tupper and Mr. E. R. Davis received the guests and forty hostesses passed coffee and cake and introduced the guests to one another. The large room looked most attractive with bouquets of spring flowers and two large coffee tables set up at either end.

Mrs. Whitson welcomed the wives attending, and asked Mrs. Lilian Robertson of the Toronto office to describe what the Ottawa and Hamilton groups are doing, and the proposed national organization which will be discussed at the E.I.C. annual meeting in Banff.

During the afternoon Mrs. H. L. Hillgartner, Mrs. L. C. Sentance, and Mrs. G. L. Schneider arrived from Hamilton with the good wishes of their group, and a telegram of congratulations came from the Ottawa Wives Association.

There were expressions on all sides



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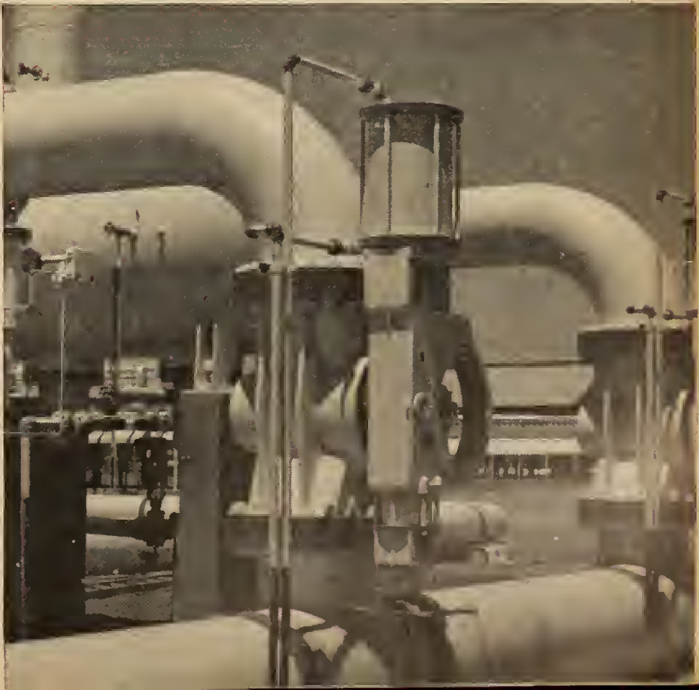

of pleasure that such a group is now formed in Toronto. It is expected that the next meeting in October will be even more successful.

Names of those comprising the committee in charge of the event are: Mesdames D. D. Whitson, K. F. Tupper, E. R. Davis, C. D. Carruthers, Peter Dalton, W. H. Paterson, C. E. Potter, and D. S. Moyer.

VANCOUVER

A. D. CRONK, JR.E.I.C.,
Secretary

T. F. HADWIN, M.E.I.C.,
Branch News Editor

W. M. Armstrong Talks on Steel

"Planning a Steel Industry for British Columbia" was the subject of an address before the Vancouver Branch of the Engineering Institute of Canada on February 28. The subject is of particular interest to British Columbia at this time and the speaker, Mr. W. M. Armstrong, was well qualified to speak with authority on the subject. Mr. Armstrong is well known in Vancouver and British Columbia being prominent in the consulting and teaching fields. Hs is an Associate Professor of metallurgy at the University of British Columbia and conducts a consulting practice. He was supervisor of the metallurgical laboratory of the Steel Company of Canada and in 1946 joined the B.C. Research Council.

Value to Province

Mr. Armstrong first indicated the value of a steel industry to the Province by giving the comparative values of ore in the ground at $18.00 a ton to rolled steel at $125.00 a ton. The differences was value added by wages and services within the province. The price of steel at a given location is affected materially by the cost of transportation from the mill and in the case of British Columbia this allows a margin of about $22.00 a ton over production in Eastern Canada. For the same reason of high freight costs, the British Columbia market is limited to the two western provinces. The export market cannot be relied on so that the total market is very limited and may not exceed 200,000 tons a year.

Low Costs Essential

Even this low market will permit a local steel industry providing ore is obtainable at an economic cost and the site of the plant is selected for minimum cost of power, coal and shipment to market. As ore must be mined in large daily tonnages to keep the cost down Mr. Armstrong considered that ore export must accompany local usage. He stated that known ore reserves were ample to sustain a steel industry but that total ore reserves would not be known until there was an incentive for the prospector and the miner to investigate the many outcroppings ignored to date.

As a blast furnace was impractical for the low steel tonnage that could be marketed, low cost power or natural gas would be factors determining the site of the industry. Raw material in the form of tailings is available at Kimberley, natural gas could be obtainable in many locations, low cost power was found near Vancouver and probably low cost large blocks of power will be available on Vancouver Island so that a careful economic analysis was necessary to determine the most favorable site.

Summarizing, a steel industry is economically feasible now and it may not be long before it is a reality.

Students' Night Awards

University of B.C. student, W. Calderwood, was awarded first prize; L. Hunt second prize and J. Mawdsley third prize at a presentation of engineering papers at the Branch Annual Students' Night.

• BRANCH NEWS

Host to members of the University of British Columbia Student Section, the function was held March 7, at the Faculty Club. Following dinner the students took over the meeting with C. Day, acting as chairman.

Under the direction of the University Toastmaster Club, the students had arranged an excellent program. Toastmaster J. West called on an introducer and thanker for each of the following student speakers. L. Hunt who spoke on "The Theory of the Atom as Developed by Lucretius", W. Calderwood on "The Development of Transistors" and J. Mawdsley who chose "A Very High Frequency Transmitter for Airport Traffic Control".

Three Vancouver Branch members, T. V. Berry, F. Cazalet and J. T. Turner, undertook the responsibility of judging the speakers. Mr. Berry complimented the speakers on their presentation and awarded prizes following an instructive criticism of each paper.

The Vancouver Branch vice-chairman, P. Bland, closed the meeting with a few words of appreciation to the student section for their handling of the meeting and for the way in which they had demonstrated the value of the student Institute activities.

Taken at the Annual Students' Night of the Vancouver Branch earlier this year, l. to r. are shown, C. Day, chairman of the U.B.C. student section, and prize-winners, H. Hunt, J. Maudsley, and B. Caldherwood.

At right are l. to r.: C. Day, H. C. Gunning, dean of applied science, U.B.C.; P. N. Bland, Branch vice-chairman; and W. O. Richmond, president of the A.P.E.B.C.

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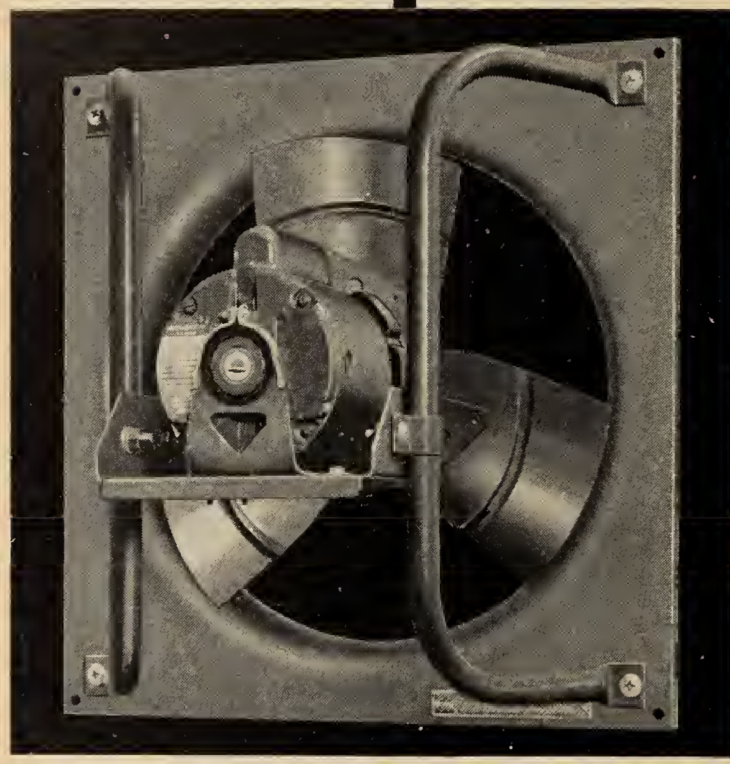
top performance and economical ventilation



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You can count on Canadian Sirocco Ventura Fans to do the job they are designed for, with high efficiency and a minimum of maintenance. They are built for long life and top performance. All ratings are certified.

Canadian Sirocco Model K Ventura Fans are ruggedly constructed, heavy-duty propeller fans for tough industrial applications. They offer the power you need . . . when you need it, and will operate against static pressures up to ⅝″. Request Bulletin 6514-C.

Canadian Sirocco Ventura Fans are attractively designed, quality built, and easy to install . . . *yet competitively priced.* Ventura Fans come in a wide range of sizes and capacities — with constant-speed and two-speed direct drives, totally enclosed motors — to satisfy your exact requirements.

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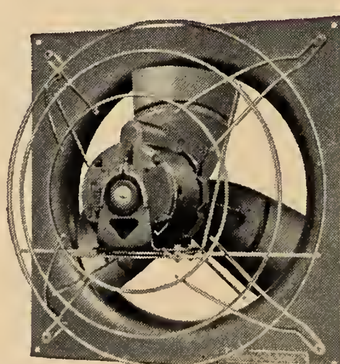

Model G Ventura Fans

Model G, at left, is a sturdily built and attractive fan suitable for light industrial duty and commercial applications. It is especially quiet-operating, making it ideal for offices, stores, and lobbies—or wherever quiet operation is required.

For further information, contact **Canadian Sirocco Products, 310 Ellis Street East, Windsor, Ontario.**

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News of Other Societies

Canadian Aeronautical Meeting

Group Captain H. R. Foottit of Ottawa, director of aircraft engineering, A.F.H.Q. was elected president of the Canadian Aeronautical Institute at the annual meeting of that Institute held on May 27 and 28, in Ottawa.

S. L. Britton, of Orenda Engines Limited, Toronto, was elected vice-president, and nine councillors also took office during the meeting.

The McCurdy Award for technical achievement was presented to E. K. Brownridge. The F. W. (Casey) Baldwin Award, a newly established medal for the best paper published in the Institute's *Journal*, was presented to H. T. Stevenson and Dr. P. Mandl of the N.A.E., for a paper entitled, "A Repeating Parachute". The Hon. J. A. D. McCurdy personally presented the first award, and Mrs. F. W. Baldwin presented the Baldwin awards.

Fourteen technical papers were presented during the two-day meeting to an audience of Canadian and American aeronautical engineers.

C. A. Bloom of Canadair Limited detailed the elaborate tests used to ensure that the *Argus*, largest aircraft ever built in Canada, would be safe and reliable. Two R.C.A.F. officers, S/L O. B. Philp and F/L K. D. J. Owen, described the cooperation needed between test pilots and flight test engineers. J. A. Fortune of Orenda Engines Ltd., Toronto, reviewed the use of non-metallic material in jet engines. K. B. Young, International Nickel Company of Canada, Ltd., told of the search for new metals for high temperatures.

R. V. Campbell and S. C. M. Ambler of British American Oil Company Ltd., discussed lubricants for modern aircraft engines. E. J. Richards, of the University of Southampton, England, gave information on noise research in the United Kingdom, as related to jet aircraft. Canadian research on this problem was recounted by Dr. K. K. Neely of Defence Research Medical Laboratories.

Icing problems occupied an entire session of the meeting; with papers on Some Aspects of Helicopter Icing by J. R. Stallabrass, of N.R.C.; on Aircraft Gas Turbine Ice Prevention, by D. Quan of Orenda Engines Ltd., and C. K. Rush, of N.R.C.; and Ice Crystals, a New Icing Hazard, by O. R. Ballard, Ministry of Supply, and B. Quan, of N.R.C.

In a session on Aviation Medicine and Human Engineering, there were three papers: Introduction of Human Engineering, R. E. F. Lewis, Avro Aircraft Limited; Safety First and Always; by J. A. Gillies, R. J. Burden, and K. E. Marsden, of Canadian Pacific Air Lines Limited; Specific Aeromedical Problems in High Performance Aircraft, S/L R. A. Stubbs, of the R.C.A.F., Institute of Aviation Medicine.

The meeting included a session on aerodynamics, which took the form of an unprepared and informal general discussion. Presiding was R. J. Templin of N.R.C., and leading the discussion were Dr. G. W. Johnson, DeHavilland Aircraft of Canada Limited, H. C. Eatock, Orenda Engines Limited, and S. J. Pope, Canadair Limited.

E. T. Jones, director general of technical development (air) of the Ministry of Supply, was the principal speaker at the annual dinner, May 27. Mr. Jones is the president of the Royal Aeronautical Society.

Canadian Good Roads Convention

Saskatchewan will be host this year to the 38th convention of the Canadian Goods Roads Association. Hon. J. T. Douglas, general chairman of the Convention Committee and Minister of Highways and Transportation of Saskatchewan, in a letter to members and friends of C.G.R.A., promises a warm western welcome. The place is Saskatoon, the dates September 25 to 27.

C.G.R.A.'s convention, the national "Parliament of Roads", is the most widely representative meeting of road interests held in Canada during the year.

The Bessborough Hotel has been chosen as convention headquarters. To ensure sufficient accommodation there and in other good hotels and motels, a housing committee has been set up.

Representatives of provincial, federal and municipal governments and of industry from all parts of Canada will confer on road and street problems and discuss developments in the highway transportation industry. The meeting will be opened by Honourable W. J. Patterson, Lieutenant Governor of Saskatchewan. Premier T. C. Douglas will be the speaker at the annual banquet, September 27.

C.G.R.A.'s president, Hon. P. A. Gaglardi, Minister of Highways of British Columbia, will preside over the convention and deliver the annual review on significant matters in the national highway picture. Arthur C. Nagle, assistant to the executive director of the International Road Federation, Washington, D.C., will present an address for that organization.

Luncheon speaker will be Bertram D. Tallamy, Federal Highway Administrator in the United States.

The technical sessions of the convention will bring together some of the most distinguished highway technologists in Canada.

A regular feature of C.G.R.A. conventions, "Forum 57", will occupy one and a half days, with speakers and discussions on soils and materials; economics, finance and administration; planning and design; safety education; traffic education; traffic engineering; and construction and maintenance.

C.G.R.A. delegates will hear from Dr. Gordon D. Campbell, engineer observer on the AASHO road durability test. The "Roads Round-Up" will again report road building activities across Canada.

The C.G.R.A. office is at 270 Maclaren St., Ottawa.

Welding Council

As was earlier announced in the *Journal*, membership for Canada in the International Institute of Welding is now held by the Canadian Welding Bureau, the Canadian Welding Society and the Department of Mines and Technical Surveys. In order to expedite and direct the activities of the I.I.W. in Canada, these participating members have joined together to form a Canadian Council. The first meeting was held December 1956.

This new Council will now direct and conduct the affairs of the Institute and its Commissions in Canada.

The purpose of this first meeting was to adopt rules and regulations governing the activities of the Council, to elect officers, to draw up a budget and to appoint delegates to represent the Canadian Council at the 1957 Congress of I.I.W.

Appointed chairman and executive secretary, respectively, were R. A. Dunn and W. R. Stickney. These appointments are effective from January 1957 to September 1957. Delegates to the Canadian Council are W. P. Campbell and H. J. Nichols, of the Department of Mines and Technical Surveys; R. M. Gooderham and W. R. Stickney of Canadian Welding Bureau; and R. A. Dunn and E. A. Gill, of the Canadian Welding Society.

● OTHER SOCIETIES

H. Thomasson of Canadian Westinghouse, R. A. Dunn, and R. M. Gooderham were appointed to represent the Canadian Council at the 1957 Congress in Germany.

It is the work of the Council to serve the interest of its three sponsor bodies, and Canadian science and industry in the activities of the International Institute of Welding, and to officially act jointly on their behalf in such activities. The Canadian Council will strive to select official chairmen, alternates and experts to serve on I.I.W. Commissions. Each member country is entitled to representation on these Commissions by one delegate who may be assisted by experts. The Commissions meet on occasions of assemblies of the Institute. The chairman will be responsible for organizing the work of the parallel Canadian commissions. Through these parallel Canadian commissions the Council will strive to publish for its sponsor bodies and for Canadian industry the vast wealth of knowledge available through the international body.

At the present time actual delegates appointed to I.I.W. commissions and also serving as chairman of Canadian commissions are as follows: Guy Savard, Canadian Liquid Air, the Commission on Gas Welding; R. F. Scott, Horton Steel Works, the Commission on Electric Arc Welding; W. A. Amos, Upton, Bradeen and James, the Commission on Resistance Welding; W. P. Campbell, Department of Mines and Technical Surveys, the Commission on Control of Welding; G. dal Molin, Northern Electric, the Commission on the Creation of a Dictionary; H. J. Nichols, Department of Mines and Technical Surveys, the Commission on Weldability; George Hamer, Horton Steel Works Ltd., the Commission for Stress Relieving in Welds; A. Clarke, Ontario Paper Company, the Commission for the Study of Brittle Fractures.

Calendar

Aeronautical Engineering

The Institute of the Aeronautical Sciences (2 East 64th St., New York 21) announces the National Naval Aviation meeting for August 5 to 10, at San Diego, Calif. The I.A.S. is co-sponsor of the sixth International Aeronautical Conference, (with the Royal Aeronautical Society) at London and Folkstone, England, September 1 to 16, 1957.

Pan-American Meeting

The Seventh Pan-American Highway Congress will take place in the City of Panama from August 1 to August 10, 1957.

This meeting has been called by the Inter-American Economical and Social Council. The Organizing Committee is at: "Palacio Legislativo, Calle 22 B, Apartado 3543, Panama, R. de P.

Symposium on Gas Dynamics

The second symposium of the series initiated by the American Rocket Society and Northwestern University will be held August 26-28, 1957 at the Technological Institute of Northwestern University, Evanston, Ill.

Theme of the meeting will be "Transport Properties in Gases at High Temperatures and Pressures".

It is hoped that the symposium will be of interest to scientists and engineers concerned with research and development entailing the transfer of mass, energy and momentum.

Inquiries may be addressed to: Dr. Ali Bulent Cambel, Gas Dynamics Laboratory, Northwestern University, Evanston, Ill., U.S.A.

Chemical Engineering

The American Institute of Chemical Engineers will hold two meetings during the closing months of 1957. The first will be held at the Lord Baltimore Hotel, Baltimore, Maryland, September 15-18. The second takes place in Chicago, from December 8 to 11, at the Conrad Hilton Hotel.

Construction Engineering

The Canadian Construction Association western regional meeting will be held this year from September 12 to 15 at Jasper Park Lodge, Alta.

Canadian Construction Association headquarters are at: Construction House, 151 O'Connor St., Ottawa.

Industrial Chemistry

The thirtieth International Congress on Industrial Chemistry will be held at Athens, Greece, September 17 to 24, 1957.

Held in one of the centres of European culture it is expected to attract chemists, scientists and technicians from all parts of the world.

As in former sessions, meetings will be accompanied by visits to various factories. A complete program for sightseers has already been arranged to allow excursions during and after the Congress.

Further information may be had on writing: Trentieme Congres de Chimie Industrielle, Comite D'Organisation, 10 rue Kaningos, Athenes, Grèce.

Material Handling Meeting

A wide range of subjects will be discussed by 23 Canadian and American specialists at the conference sessions of the Canadian material handling show and conference September 30 to October 4, 1957 in Montreal.

Sponsored by the Montreal Chapter of the American Material Handling Society, four panel discussions will be held the first day, followed by group discussion and the Canadian Material Handling Clinic on the consecutive days.

Further information may be had on enquiry from: M. H. Engeland, c/o Sherwin Williams Company Limited, 287 Centre Street, Montreal, Que.

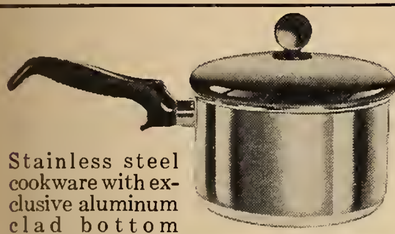
Correction

In the May issue of The Engineering Journal, (Page 631) this picture of the 450-ft. cement kiln of Canada Cement Company Limited at Woodstock, Ont., was inadvertently reproduced in the wrong position. This is the correct view of the unit.

ATLAS STEEL NEWS

TOOL STEELS • HIGH SPEED STEELS • MINING DRILL STEELS • SPECIAL PURPOSE STEELS • STAINLESS STEELS

WHAT'S NEW IN STAINLESS products for the home



Stainless steel cookware with exclusive aluminum clad bottom (patented)—latest product from Sunshine Waterloo Co. Ltd.—features a design-award-winning nine-piece set including covered saucepans, skillets and boilers which are available in three sizes. For lifetime beauty and service these utensils are made of type 302 Atlas Stainless Steel.

True beauty with utility is evident in cutlery made of Stainless Steel.

Illustrated, a knife, fork and spoon in Oneidacraft "FLIGHT" pattern which features elegant design with lifelong wear. Easy-to-clean, always sparkling, a pleasure and pride to have on your table—that's cutlery made from Stainless Steel.

CHALLENGE!

From Norway comes something new and exciting—stainless steel decorator bowls and plates in many beautiful "baked-on" enamel colours. Here is a challenge to the Canadian designer—a challenge that he can easily meet with Atlas stainless steel.

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BRANCHES: TORONTO, MONTREAL, HAMILTON, WINDSOR, WINNIPEG, VANCOUVER

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Designers And Consumers Join the Swing to Stainless

Right across Canada—indeed, right across the world—more and more designers and consumers are turning to stainless steels for beauty and durability that defies time. In the kitchen . . . on the dining table . . . for the family car . . . for any place where lasting quality must stand the test—Atlas Stainless Steels are proving the wisest, most practical choice for better modern living. As Canada's *only* basic producer of stainless steel to any specification, Atlas Steels Limited is proud to be the leader in Canada's newest trend.

Why G.E. Chose Atlas Stainless Steel Tubing For This Refrigerator De-Frost Valve

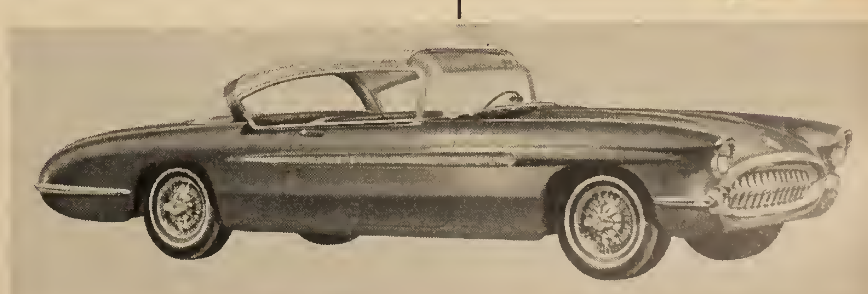
General Electric chose Atlas Stainless welded tubing, type 304, for this most intricate valve body because it provided a closer diameter tolerance than could be obtained with seamless tube. This is only ONE instance where Atlas Stainless Steel Pipe and Tubing has filled a vital need. For the whole story on these precision made Atlas products write us for this illustrated brochure.

UPTREND IN USE OF STAINLESS FOR AUTOMOBILES

Stainless steel is making itself felt more and more in the automobile industry. For example, wheel covers for all the "big three" cars—Chevrolet, Plymouth and Ford—are now made for a lifetime of beauty with gleaming, rust-proof stainless steel. Plans for the future include many additions to the long list of parts and accessories now made from stainless.

Shown below is one of General Motors' cars of the future the "Impala" . . . which features shaded pale blue stainless steel roof, and a long blue fibreglass body embellished with tasteful silver blue stainless steel. As illustrated by this application, the natural beauty of stainless can be enhanced by a coat of transparent color glaze.

The "Impala" contains many spectacular new features which may be incorporated in future stock model G.M. cars.



Library Notes

Additions to the Institute Library

Reviews, Book Notes

Standards

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

AIRCRAFT HYDRAULICS, V.1 HYDRAULIC SYSTEMS

Although the design and manufacture of hydraulic equipment for aircraft is such an important part of the industry, very few textbooks have so far been made available. The Royal Aeronautical Society is trying to remedy this by issuing a series of texts for students which will also prove of interest to practicing engineers.

This first volume is concerned with the general problems of hydraulic systems, and includes chapters on fluids; hydraulic theory as applied to aeroplane systems; hydraulic systems and circuits; the installation, operation and testing of systems.

Later volumes in this most useful series will discuss component design of aircraft hydraulics and landing gear design. (Ed. by H. G. Conway. Toronto, British Book Service, 1957. 146p., $6.00.)

*ANNUAL REPORT ON THE PROGRESS OF RUBBER TECHNOLOGY, VOLUME 20

This selective review of the developments and literature of 1956 has separate papers on a wide variety of rubber goods for industrial and other uses. There is a general historical and statistical review of the year, also papers on planting, production, properties, compounding ingredients, testing, and the chemistry and physics of rubber and latex. (Ed. by T. J. Drakely. London, Institution of the Rubber Industry, 1957. 141p. 25/-.)

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS
Monday to Friday
9 a.m. — 5 p.m.

AUTOMATIC CODING

The eight papers given at a symposium on automatic coding held in January 1957 by the Franklin Institute are reproduced in this volume, outlining new techniques and new applications of automatic coding for digital computers used in industry and science. The authors of the papers are all experts on automatic coding, and they present the latest information and experience available in this expanding field. (Philadelphia, Franklin Institute, 1957. 118p., $3.00. Institute monograph no. 3.)

BASIC REINFORCED CONCRETE DESIGN: ELASTIC AND CREEP, 2ND ED.

A textbook for a basic course in reinforced concrete design, the new material in this edition includes chapters on creep, shrinkage, ultimate strength and prestressed concrete. The book covers the fundamentals of beam bending, shear, columns and practical continuity, introducing each new topic at an elementary level, and showing how problems may be solved by methods already familiar to students. Solution by formulas or charts are introduced later. The author includes full page calculation sheets showing design methods.

The 1956 American Concrete Institute Building Code has been followed and is explained in the text. There are problems and bibliographies included in each chapter. (By G. E. Large. New York, Ronald, 1957. 527p., $7.00.)

BETON-KALENDER 1957: TASCHENBUCH FUR BETON UND STAHLBETONBAU

The forty-sixth edition of this well-known handbook needs no introduction to those connected in any way with concrete construction. All types of cement and concrete are dealt with, and all aspects of concrete construction. Each chapter is written by a specialist, and much of the information is given in tabular form. Reference is made throughout the book to the German standards for steel and other construction materials.

This is an invaluable reference book, incorporating as it does all the latest German information. (Ed. by George Ehlers. Berlin, Ernst, 1957. 2vols, 18DM.)

CARGO SHIP LOADING

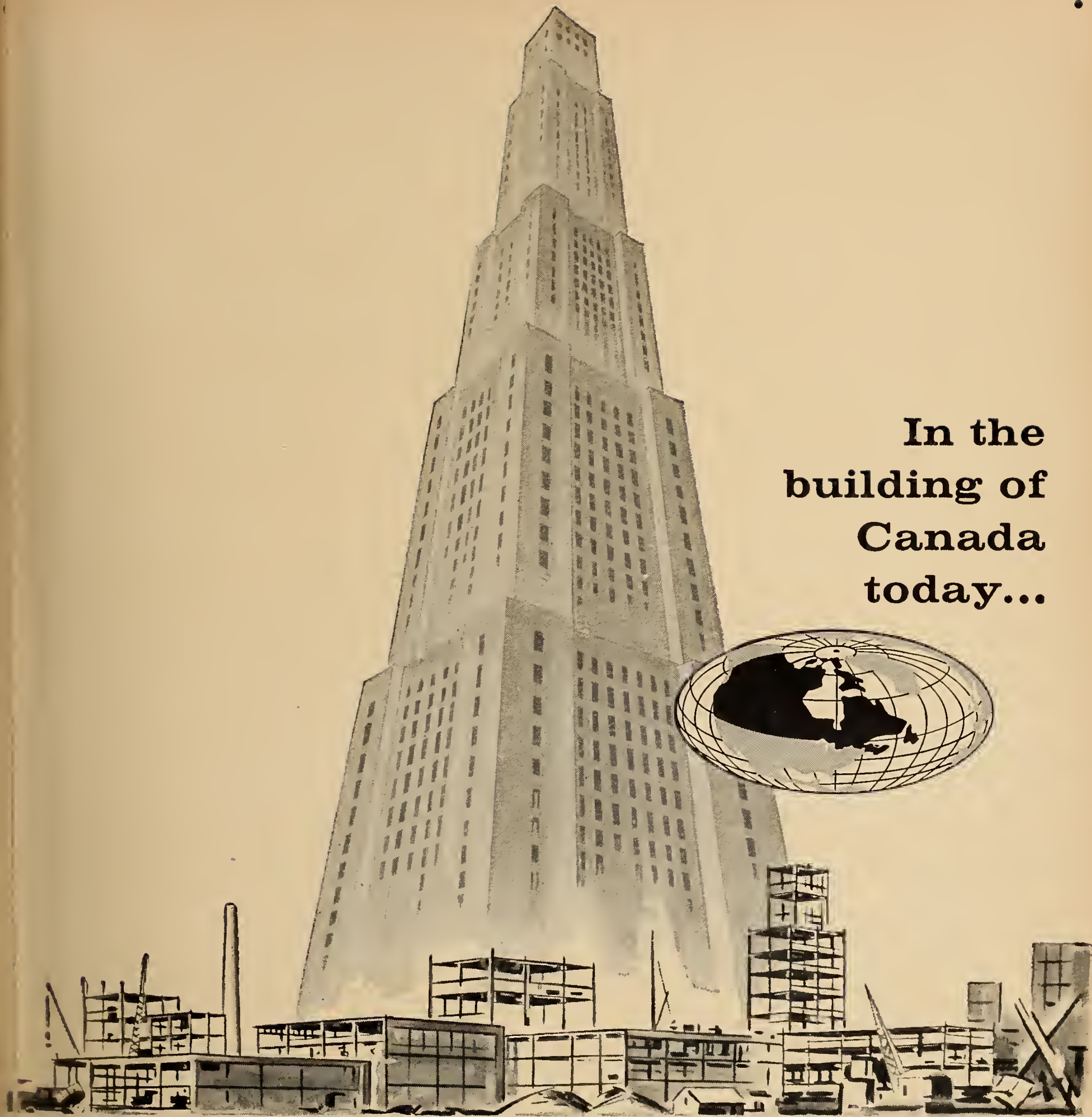
An analysis of general cargo loading in selected ports in the United States, this report presents data on overall loading rates, on various loading processes, costs, and estimated break-bulk loading capabilities. Much of the material is presented tabular form, and the conclusion reached is that most loading systems are operating well below their capacity. It would be interesting to see the results if a similar survey were made in Canada. (Maritime cargo transportation conference. Washington National Research Council, 1957. 91p., $2.00. Publication no. 474.)

COMBUSTION AND HEAT TRANSFER IN AN OPEN-HEARTH FURNACE

This is the report of a large scale trial initiated with the object of checking a mathematical theory of heat transfer in the open-hearth furnace. The team which carried out the test was composed of specialists from British industry, the Iron and Steel Research Association, and the University of Sheffield.

The report covers such topics as design and control of a trial furnace, combustion measurement and control, temperature measurements, heat losses through the brickwork, and general heat balance.

The trials demonstrated that the theory was essentially sound in predicting the influence of flame characteristics on heat transfer, and on working rates. The authors indicate that there is still much research to be done in relating theory and practice in the open hearth



furnace. (London, Iron and Steel Institute, 1956. 82p., 37/6. Special report no. 59.)

°ELASTIC BEHAVIOUR OF STRUCTURAL MEMBERS: THE FRAME CONSTANT METHOD

The method of stuctural analysis presented in this book is based upon "The various deflections of the free end of a member considered as fully restrained cantilever beam with all the direct loads applied and the influences of all the members in this system considered as loads." The author provides detailed analyses of a variety of structural members, discussing elastic behaviour, moment equations, the unit beam, the general behaviour of the continuous girders of from two to six spans. Charts and tables are included as necessary. The present volume considers only those structural members with constant moment of inertia. (By Odd Albert. Belmar, N.J., Opla Company, 1956. Various paging, $6.00.)

°ELASTIC WAVES IN LAYERED MEDIA

The outgrowth of a plan to make a uniform presentation of investigations on earthquake seismology, underwater sound, and model seismology, the scope of this book was enlarged to include a selection of related problems. Many of the methods used in seismological problems were originally developed in studies on electromagnetic waves and in general the methods used in the work covered by this book are close to those used in electromagnetic waves, water waves and shock waves. Extensive bibliographies are included. (By W. M. Ewing, W. S. Jardetzky and F. Press. Toronto, McGraw-Hill, 1957. 380 p., $10.00.)

ELECTRICITY AND MAGNETISM

This textbook commences with two introductory chapters on electrostatics and magnetism, followed by a study of current electricity, including electrolysis, electromagnetism, electrodynamics and capacitance.

The often abstract concepts of electricity are fully explained, and are followed by chapters which cover electrostatics and magnetism in more detail. An introduction to the physics of the atom is included, as is an explanation of the m-k-s system of units. Many of the questions included in the chapters have been taken from the examinations set by University of London. (By J. Newton. New York, Philosophical Library, 1956. 613p. $10.00.)

°ENGINEERING ECONOMY, 2ND ED.

The theory and practice of the determination and evaluation of economic factors are here set forth for engineers and engineering students. This edition, in addition to general revision, has a new chapter on income taxes in engineering economy studies. Other subjects treated in the book include: depreciation; first, fixed, variable, incremental, differential, marginal, and sunk costs; break-even and minimum cost points; evaluation of replacements; and economy and utilization of personnel. (By H. G. Thuesen. Englewood Cliffs, N.J., Prentice-Hall, 1957. 581p., $6.95.)

°ENGINEERING ENROLLMENT IN THE UNITED STATES

Presents basic statistics on the subject in both tabular and graphic forms. The period covered varies but generally includes the last 25 to 35 years. In addition to general coverage there are chapters on all major fields of engineering, and one chapter on engineering training in Russia. Considers the effects of proliferation of curricula in engineering specialities, large-scale enrollment in graduate study, and attrition of engineering students. Concludes that the current shortage of engineering talent is critical with respect to engineers with a high degree of mathematical and scientific orientation and those with unusual analytic and design creativity. (Ed. by N. N. Barish. New York, New York University Press, 1957. 226p. $7.50.)

FORGEMASTERS' MEETING 1954

In 1954 a joint meeting was held in London by the Iron and Steel Institute, the National Forgemasters' Association and la Chambre de la Grosse Forge Française at which papers were presented by authors from both sides of the Channel. The topics covered included the production and ultrasonic inspection of heavy upset forgings; thermal stability testing of rotor forgings; continuous grainflow process; heating and soaking of ingots for forging, etc. References are given in most papers, and the discussion following the papers is also reproduced, adding to the value of this interesting volume. (London, Iron and Steel Institute, 1957. 92p., 37/6. Special report no. 60.)

°FROST UND TAUSCHÄDEN AN VERKEHRSWEGEN UND DEREN BEKÄMPFUNG

A specialized treatment of frost and thaw damage to highways and railways. The book cites the basic factors; discusses the primary and secondary influences of weather, structural conditions, surfaces, loads, etc.; gives a résumé of current knowledge; and devotes a considerable section to remedial or preventive measures, both for existing roads and for new construction. (By L. Schaible. Berlin, Ernst, 1957. 176p., DM22.)

THE GENERAL THEORY OF ELECTRICAL MACHINES

Based on a graduate course given at Imperial College, London, this volume, as its title implies, presents a general theory applicable to all types of electric machines, rather than concentrating on one particular type. The author was a designer and consulting engineer with British Thomson-Houston for twenty years, and his experience is incorporated in this book, as is much information obtained from published papers which are listed in the bibliography.

The author discusses the basis of the general theory, methods of analysis, D.C. and A.C. machines, synchronous and induction machines, methods for generator and system analysis and the generalized rotating machine.

Much of the material presented is necessarily at an advanced level, but many of the ideas are simple, and can be used in teaching undergraduate courses. The volume is one of a series of advanced engineering textbooks written by the staff of the British Thomson-Houston. (By Bernard Adkins. Toronto, British Book Service, 1957. 236p., $7.75.)

°A GUIDE TO THE LITERATURE OF CHEMISTRY, 2ND. ED.

This important reference book, first published thirty years ago, has now been thoroughly revised to keep pace with the rapid growth of chemical literature. The authors describe and classify the important books, journals, indexes, and other types of literature; discuss such sources of data as patents, trade publications, theses, and unpublished material, and outline helpful principles for searching the literature. Lists of symbols, information on libraries, and other useful data is given in extensive appendixes. (By E. J. Crane, A. M. Patterson, and E. B. Marr. New York, Wiley, 1957. 397p. $9.50.)

HIGH SPEED DIESEL ENGINES, 6TH ED.

A well known and reliable text fo[r] over twenty years, this new edition ha[s] been largely rewritten, and new chap[-] ters added on supercharging, small ve[-] hicle engines, air-cooled and speci[al] purpose engines, and the starting of en[-] gines.

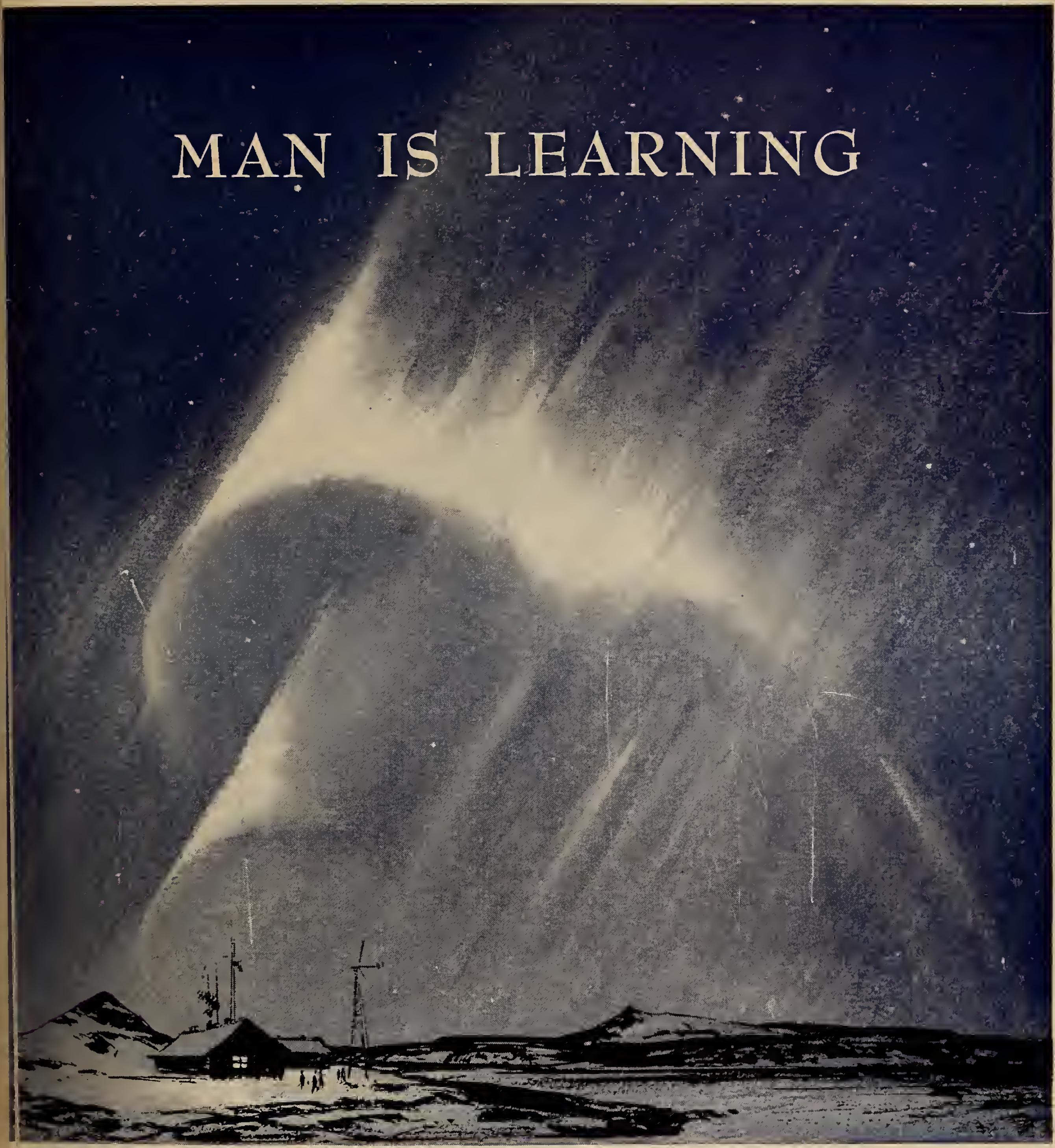
The material is presented at a fairl[y] elementary level, and covers the gen[-] eral principles and the construction [of] small and medium sized engines, wi[th] special reference to traction, stationa[ry] and marine types. (By A. W. Judg[e]. Toronto, British Book Service, 195[7]. 578p., $11.10.)

°HILFSTAFELN ZUR BERECHNUNG WANDARTIGER STAHLBETONTRÄGER

Tables and graphs for the design [of] deep panel-type reinforced - concre[te] girders as used in silos and bunkers. T[he] accompanying text provides the theore[t-] ical basis, analysis of loads, the fo[rm] and reinforcement of panel-type girde[rs] and three examples of calculations. ([By] O. Theimer. Berlin-Wilmersdorf, Ern[st], 1956. 38p., DM 7.20.)

A HISTORY OF MECHANICS

This history of one of the most i[m-] portant branches of the history of scien[ce]



MAN's unceasing quest for more knowledge of space and his world will continue with new vigour during the International Geophysical Year. Of the 43 countries uniting to make simultaneous observations, Canada's contribution will be significant for its studies of the ionosphere and of changes in the earth's magnetic field. Canadian Applied Research Limited is honoured to work with the Canadian scientists. Such new and unique instruments as the Auroral Recorder, the Stationary Magnetometer and a recording camera were engineered and produced for the project by Canada's leading instrumentation firm.

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MEMBER • A. V. ROE CANADA LIMITED & THE HAWKER SIDDELEY GROUP is the first to appear for more than sixty years, and the author not only re-evaluates early history in the light of modern knowledge and ideas, but introduces recent developments. The text is translated from the edition published in Switzerland in 1950.

Part 1 deals with the forerunners and pioneers of the field of mechanics, covering the important men, schools of thought, fields of activities, and developments from the Greeks and Arabs to the time of Kepler in the 17th century. The formulation of the classical mechanics during the 17th century is discussed in part 2, with parts 3 and 4 covering the organization and development that took place during the 18th and 19th centuries. Part 5 takes up the 20th century concepts: the relative theory; quantum mechanics; wave mechanics; and the various developments of statistical mechanics. (By René Dugas. New York, Central Book, 1956. 671p., $15.00.)

*HYDRAULICS OF MULTIPLE MAINS

A book that will serve somewhat as a manual or handbook for engineers employed in enlarging or modernizing an inadequate water supply system. There are sections on classification and design of mains, basic equations for fundamental hydraulics, relative rates of flow for feeder mains, and pipe lines in series and in parallel. The concluding chapters give material on additional pipe lines, the life of the system and typical problems. The appendix contains nomographic charts. (By O. G. Goldman. Connecticut, Columbia Graphs, 1957. 145p., $6.50.)

*MECHANICAL ENGINEERING LABORATORY INSTRUMENTATION AND ITS APPLICATION

The author makes a distinction between part 1 which is devoted to the subject of instrumentation and part 3 which deals with the applications of instrumentation to typical engineering problems. Part 2, Determination of selected physical and chemical properties of fuels and lubricants, introduces the engineer to some of the tests developed by ASTM and ASME for obtaining qualitative evaluation of many complex physical properties which cannot be measured directly. Although intended for the first courses in mechanical engineering, it is designed to give necessary background for all laboratory courses in this field. (By J. S. Doolittle. New York, McGraw-Hill, 1957. 396p., $6.50.)

*MOTION ECONOMY AND WORK MEASUREMENT

This revision of the book previously published under the title "Time study and motion economy" has been expanded to include the application of motion study to office work, micromation study, use of film in motion study, motion time standards, work sampling (ratio delay), fatigue measurement, and recent material in connection with automatic machines. Emphasis is on application and theory for application. Charts, graphs and tables are extensively used to illustrate the text material. (By R. L. Morrow. New York, Ronald Press, 1957. 468p. $7.50.)

*NUCLEAR REACTORS FOR RESEARCH

In this third volume in the Geneva Series on the Peaceful uses of atomic energy, part 1 contains the following sections: the kinds of institutions that may wish to build and install a research reactor, and their fields of research; technological factors affecting choice; performance data, safety considerations and the uses of research reactors in physics, chemistry, engineering and biology. Part II describes research reactor projects of all types now in operation at specific locations in Europe and America, including Russia. The book provides a list of the papers relevant to research reactors presented at the 1955 Geneva Conference, a subject index, and a name index. (Ed. by C. K. Beck, Toronto, Van Nostrand, 1957. 267p. $8.50.)

*PHYSICAL BASIS FOR ELECTRICAL ENGINEERING

This textbook is concerned with the broad physical basis of electrical engineering phenomena; theory and concept are stressed rather than experimental or


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analytical methods. Both the macroscopic and microscopic viewpoint are presented. The chapters contain material on electrostatic and static magnetic fields in vacuum, extranuclear atomic structure, nuclear structure, structure and behaviour of metals, semiconductors and semiconductor devices, vacuum tubes, insulators and capacitors, magnetic properties of matter and inductance. Problems are given at the end of each chapter, and charts and diagrams are included throughout. (By T. L. Martin, Jr. Englewood Cliffs, Prentice-Hall, 1957. 410p. $10.00.)

*PLASTIC DESIGN OF PORTAL FRAMES

This volume deals with the practical application of the plastic theory of design developed at Cambridge University in England. Intended for practicing engineers and advanced students, the book gives a concise exposition of basic principles and show the application of the method to the design of the single-storey, pitched roof portal frame. Practical design examples are worked out. (By J. Heyman. Toronto, Macmillan, 1957. 104p., $2.00.)

PRACTICAL GEOMETRY AND ENGINEERING GRAPHICS, 6TH ED.

The first section of this textbook covers plane geometry and engineering graphics, paying particular attention to the applications of graphical methods of computation. The second part is concerned with solid, or descriptive, geometry. There are numerous illustrations and worked examples.

This is the sixth edition of a work first published in 1929, and is intended for those students who already have a knowledge of elementary plane geometry, graph plotting and the use of vectors. (By W. Abbott. London, Blackie, 1956. 366p., 22/6.)

PRODUCTION ENGINEERING: JIG AND TOOL DESIGN, 6TH ED.

This popular work has now reached its sixth edition in sixteen years, and the two chapters added cover transfer machining, which is a stage between the usual operation on a single machine and complete automation, and recent achievements in deep-hole trepanning.

The author brings many years experience to the writing of this book, which is highly recommended by the Institution of Production Engineers, and will be welcomed by experienced jig and tool designers, as well as by students. (By E. J. H. Jones. Toronto, British Book Service, 1956. 355p., $5.10.)

*PROJECT ENGINEERING OF PROCESS PLANTS

Written to record information and techniques in plant design and to discuss ideas developed by process engineers, this book is for the project engineer and for any engineer who designs process plants or equipment. The four sections are: major steps in plant design; business and legal procedures; detail of engineering design and equipment selection; and construction of the plant. Chemical engineering plants and equipment are emphasized but some of the material will be applicable to other fields. (By H. F. Rase and M. H. Barrow. New York, Wiley, 1957. 692p. $14.25.)

*THE PROSPECTS OF NUCLEAR POWER AND TECHNOLOGY

A non-technical report on the present status of nuclear fission, and an appraisal of the future of our society in a nuclear age. Part 1 gives a comprehensive picture of actual and future atomic energy plants here and abroad, the legal and economic factors involved, and the social consequences. Part II covers the technology of nuclear industries and the problems which have arisen. The processing, extraction and disposal of fission products, and future prospects are discussed in this part. (By G. Wendt. Toronto, Van Nostrand, 1957. 348p. $6.00.)

RUBBER IN ENGINEERING

The five papers presented at a recent conference on rubber in engineering

have been reprinted by the Natural Rubber Development Board. The first paper dealt with the correct use of rubber, and set the tenor of the symposium. The remaining papers covered load deflection relations and surface strain distributions for flat rubber pads; the use of rubber in heavy engineering; dynamic fatigue life of rubber components; and rubber in agriculture. The value of these excellent papers is increased by the illustrations and discussion included. (London, Natural Rubber Development Board, 1957. 160p., free.)

THE SPECIFICATION AND MANAGEMENT OF MATERIALS IN INDUSTRY

A long-neglected subject in the field of productivity control, materials application engineering is discussed at length in this book. As a means of achieving better quality and lower costs as well as improved managerial co-ordination and control, the author describes the utilization of the principles of standardization, purchasing and inspection work and the conduct of a departmental office and laboratory. The point of view used is that of a manufacturer engaged on quantity production in general precision light engineering work. Materials used by such a firm must be both specified exactly for the particular job in hand, or difficulties will occur at various working states, and examined to see that they accord with specifications, in line with modern statistical methods.

Topics covered include the organization and running of a materials department, technical purchasing, specifications, and the conduct of a materials engineering laboratory. (C. H. Starr, London, Thames and Hudson, Toronto, Longmans, Green, 1957. 194p., 21/-.)

*STATISTICAL METHODS IN QUALITY CONTROL

The first twelve chapters are mainly on statistical methods with illustrations from the field of quality control. The subjects covered include: statistical data, elementary principles of probability, binomial and multinomial distributions. normal distribution, and analysis of variance. Chapters 13 through 29 are concerned mainly with process control including specification limits and tolerances, use of control charts for variables, and for non-normal distributions, selected techniques for analysis of defectives and the Poisson distribution. Chapter 29, dealing with the economics of control charts contains some original methodology. Chapters 30 through 40 deal mainly with product control containing such subjects as hypergeometric distribution, single, double and sequential sampling and analysis of the pattern of variability. (By D. J. Cowden. Englewood Cliffs, N.J., Prentice-Hall, 1957. 727p., $12.00.)

SURVEYING, 2D ED.

This second edition of a textbook first published in 1942 has been brought up to date, and new material added, and the chapter on aerial surveying and photogrammetry completely re-written.

The book covers the fundamentals of surveying, and places particular emphasis on the principles of the subject, and on the use of surveying instruments. Field exercises and problems are given in each chapter.

The author is well known for his other texts on surveying written in collaboration with G. L. Hosmer. (C. B. Breed, New York, Wiley, 1957. 495p., $5.50.)

*SYSTEM ENGINEERING

In organizing the various aspects involved in the systems approach to the problem of designing equipment, this book logically combines the new set of tools, new classification of parts, and the team of workers necessary to this approach. At the same time it provides for the engineer, as a member of the system-design team, a background for his job and describes system - design methods. A selective bibliography and illustrative problems with solutions are included. (By H. H. Goode and R. E. Machol. Toronto, McGraw - Hill, 1957. 551p., $10.00.)

THERMODYNAMICS

This edition of a standard college text has been extensively rewritten, reoriented, renamed and to some extent reorganized because of the increase in knowledge surrounding the concept of entropy.

This is not intended to be a complete coverage of the subject, as the reader is told repeatedly, but it does provide an outline of the information most useful to engineers, and an introduction to more advanced study. (By V. M. Faires. Toronto, Brett - Macmillan, 1957. 543p., $7.50.)

TUBE SELECTION GUIDE 1956-57

This guide is intended to aid in the selection of tubes for various purposes. Tables include: all types of tubes manufactured by Philips, or other companies; most important properties of each type; types preferable for new apparatus; tubes to be used exclusively in existing apparatus; tubes which may be used for replacement of obsolete types; descriptions of type number systems and data of tube bases and holders. A translation key enables French, German and Spanish users to understand the guide. (T. J. Krocs, comp. Eindhoven, Philips Technical Library, 1956. Irreg. paging., $1.50.)

TUBES FOR COMPUTERS

Electronic computers at the present time are serving many purposes in business and industry, and are being put to ever increasing use. The application of the electron tube in computers, although resembling ordinary amplifying circuits in operation and set-up is rather unconventional. The tubes described in this publication are especially designed for computer use. Topics covered are: computer circuits; requirements imposed on tubes in multivibrator and gate circuits; vacuum tubes in high speed and low speed computers. (Eindhoven, Philips Technical Library, 1956. 51p., $1.50.)

U.H.F. TUBES FOR COMMUNICATION AND MEASURING EQUIPMENT

The subject of this publication, the U.H.F. Tube, has become of increasing importance because of the greater use of high frequency apparatus in mobile transmitting and receiving units, as well as other modern applications. These tubes, using decimeter and centimeter ranges, are necessitated by these smaller units, as well as by the overcrowding of longer wave ranges. The use of centimetric waves requires changes in the design of conventional tubes capable of even the decimetric wave range, and the new tube types differ fundamentally in design and construction.

Included in this book is the range for U.H.F. and S.H.F. waves, as well as some applications of tubes for measurement of the noise factor at high frequencies. (Eindhoven, Philips Technical Library, 1956. 60p., $1.50.)

THE UNFIRED PRESSURE VESSEL CODE SIMPLIFIED

This simplified analysis of the new 1956 A.S.M.E. Unfired Pressure Vessel Code makes it easy to use and can save valuable time and material.

The 1957 edition contains simplified charts for internal and external pressure, shell thickness, flanged and dished head thickness, flat head thickness, flat cover plate thickness, and openings and reinforcements. Lengthy problems can be solved quickly and easily with the use of these charts. Also included in the book is a section on welding procedure which is a guide to solving welding procedure problems.

Written in an easy to understand manner, this compact book brings you, in condensed form, all the useful information gained in 20 years of approving A.S.M.E. Code design. (By Robert Chuse. Leonia, N.J., The Author, P.O. Box 91, 1956. 30p., $6.50.)

WAVE PROPAGATION

This volume, number eleven in the Electronic Technology series, deals with the various factors involved in the make-up and transmission of electromagnetic waves. Specific attention is given to wave motion, frequency-wavelength relationships, radiation, field intensity, wave fronts and polarization. Analyses are given of the natures of sky waves, ground waves, wave reflection, refraction and diffraction. A general discussion on the effect of atmosphere on radio transmission includes details on the ionosphere, stratosphere and troposphere. One chapter covers scatter propagation. (A. Schure, ed. New York, Rider, 1957. 56p., $1.25.)

• ASME-E.I.C. CONFERENCE

(continued from page 998)

es of the United States. One of the principal objectives of the Athlone Fellowship Scheme is to correct the above tendency by encouraging Canadian engineering graduates to study in Great Britain and thereby become more familiar with British industrial practices and resources. Indirectly it is hoped that the Scheme will foster an eventual improvement in the balance of trade between Britain and Canada. Fellows may choose to spend their period of postgraduate training in industry or may elect to continue their studies in a university with a view to securing a higher degree.

Relative Merits of Various Procedures

Of the various procedures which have been put into practice to encourage postgraduate study for brilliant students or employed professional graduates of merit, the scholarship or fellowship plan is undoubtedly one of the best. In this respect the experience of the National Research Council is of outstanding value to industrial employers who realize that more advanced formal training is a necessity for those engineers working on research, design and development problems. Both Canadian industrial and government organizations that must undertake research work recognize the need of providing a financial subsidy for the maintenance of highly qualified employees who would be better equipped to undertake their tasks after a period of postgraduate study.

The trend in favour of the fellowship plan is increasing steadily in industry and is well established on the government level. Canada's scientific achievements and progress in technological development could not have been realized without the N.R.C. system of encouragement and financial assistance through scholarships, research associateships and grants-in-aid. The N.R.C. is also administering a number of scholarships sponsored by outside industrial and other organizations, such as those of the Shell Oil Co., Nuffield Dominion travelling fellowships, the Merck & Co. postdoctoral fellowships and others. Major industrial employers could follow, with ultimate benefits to their organizations, the examples set by the International Nickel Co., the Imperial Oil Co. and some other industries in making provision for the continued university education of outstanding engineers to ensure professional advancement in those cases where in-service training does not provide sufficient background in the basic sciences and specialized subjects. A completely altruistic approach to the fellowship plan by industry which would make fellowships available to qualified graduates of any Canadian university is, of course, the ideal one.

Schemes which provide for leave with half pay or full pay are also meritorious and have a practical advantage in that they assure the employer that the engineer, after completion of his course of study, will return to his job. Merely granting leave, without salary or other benefits, is not a practical approach as it places the burden of financial support for the engineer and his family entirely on his shoulders. If savings prove inadequate the results can be unfortunate.

Part-time or evening courses of study are available to engineers, while fully employed, in the United States at large metropolitan centres where the universities have sufficient resources to make adequate teaching staff available to students. It is doubtful if such a plan for formal graduate study can be implemented in Canada for some time to come. There are obvious disadvantages for both the university and the student in such a course, as mentioned earlier.

The current shortage of engineers and scientific personnel leads many young graduates, who are well-qualified for postgraduate schools, to seek employment immediately after receiving the bachelor's degree. Starting salaries are now more attractive than formerly, and this provides the incentive for some. Others desire employment for financial or personal reasons or feel that they need the experience and maturing influence of industry before undertaking more advanced studies. After a period of transition, if some want to continue their education as a matter of principle or responsibility, the required assistance should be available for application.

The wide-spread practice in industry of making the top positions commanding high salaries available only to those who have supervisory, sales or administrative experience has had the result of effectively removing skilled engineers from research, design or development fields. If industry needs engineers and scientists it must provide more attractive careers than high starting salaries to remedy the situation. It should be possible for competent professional employees to attain positions equivalent to those of top management by virtue of productive and creative work, of value to the industrial enterprise, in their own fields of endeavour. This applies with equal force to those engaged in teaching at universities or in the employ of government departments.

Much has been written recently about the emphasis on the production of trained engineering and scientific manpower in Russia in relation to that in the United States and other Western Nations. In 1955, about 120,000 engineers and scientists were graduated in Russia as against approximately 70,000 in the United States. The disparity is accentuated by the fact that about 35 per cent of the graduate engineers in the United States take up other activities after graduation and do not practice engineering. In the interests of self-preservation, national economy and the continued development of our country, this problem of engineering education is one which commands the urgent attention of industry, the universities and all levels of government.

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Business and Industrial Briefs

A DIGEST OF INFORMATION RECEIVED BY THE EDITOR

Appointments and Transfers

Canadian Car Company — E. J. Cosford has been elected to the position of chairman of the board of the Canadian Car Company Limited, in succession to Sir Roy Dobson. Other appointments announced are A. C. MacDonald, vice-president and general manager, railway car division; E. G. Burgess, vice-president, planning and development, and assistant to the president; L. M. Hart, vice-president, truck and trailer sales; L. G. Main, co-ordinator of merchandising.

Canada Wire Appointment — L. G. Lumbers has been made general manager of Canada Wire and Cable Company Limited. Mr. Lumbers is a director of the company, and a vice-president and director of Telecables & Wires Ltd.

Directors Appointed — J. Gordon Mock and Charles L. Dudley have been made directors of Jenkins Bros. Limited. Mr. Mock, treasurer of the company, has also been appointed secretary; Mr. Dudley is also director, secretary, and treasurer of Jenkins Bros., New Jersey.

Dominion Structural Steel — D. D. Currie has been made sales manager, crane division, of the Dominion Structural Steel Ltd.

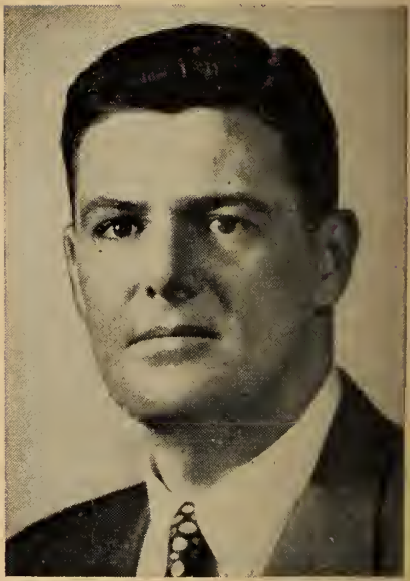
New Westinghouse Appointments — It has been announced that the two new vice-presidents of Canadian Westinghouse Company Limited are Edward E. Orlando, M.E.I.C., general manager of the district apparatus division, and John A. Campanaro, project development group general manager. Edward W. Hill has been made manager of the new utility department, district apparatus division.

Bridge & Tank Directors — The election of R. A. Robertson and Dr. Richard L. Hearn, M.E.I.C., as directors of Bridge & Tank Company of Canada, has been announced.

C.G.E. Appointments — The following appointments have been announced by Canadian General Electric Company Limited: Charles A. Morrison, vice-president, reports to board chairman Harold M. Turner and will be concerned with marketing problems; Walter G. Ward becomes general manager, wholesale department.

J. Gordon Mock

Charles L. Dudley



D. D. Currie

United Steel Vice-President — The appointment of W.T.E. Smith as vice-president of United Steel Corporation Limited, Toronto, has been announced.

British Thomson-Houston — It has been announced that H. G. McHaffie has been appointed managing director of The British Thomson-Houston Co. (Canada) Ltd.

Alexander Fleck — It has been announced that L. W. Fleck has been elected chairman of the board of The Alexander Fleck Limited, and that H. D. Hyman has been elected president and general manager. K. F. Fleck remains vice-president and secretary - treasurer. All the above, with E. D. Berry, Jr., form the board of directors.

Powerlite Appointments — Recent appointments at Powerlite Devices Ltd., Toronto, are as follows: Gordon E. Wallace, general sales manager; Ian Y. Morrison, Ontario sales manager; N. K. Newell, sales engineer.

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Indexed in The Engineering Index

THE ENGINEERING JOURNAL

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"To facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the engineering profession and to enhance the usefulness of the profession to the public."

Contents - August 1957

(18,150 copies of this issue printed)

1888

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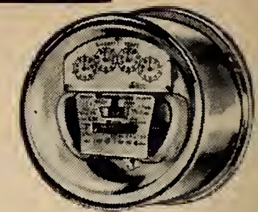

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Design and Operating Features of

The Canada-India Reactor

F. J. Bleackley, M.E.I.C.

C.I.R. Project Manager, The Shawinigan Engineering Company Limited

A paper read at the 71st Annual General and Professional Meeting of the Engineering Institute of Canada, Banff, Alta., June, 1957.

The Canada-India Reactor—known as C.I.R.—is an experimental nuclear reactor now being constructed near Bombay as a joint Canada-India project under the Colombo Plan.

The reactor is designed to provide facilities for research work on peaceful applications of atomic energy. It will be used for the development of fuels and materials for use in nuclear power reactors and for the production of radioactive isotopes for industrial, medical and scientific applications.

Plutonium may be recovered as a 'by-product' from the spent fuel elements and will be used later as a fuel in a more advanced reactor for power production. A limited amount of uranium 233 will also be produced, by irradiating thorium metal in regions of the pile where neutrons might otherwise be 'lost' in the reflector and shielding outside the areas of high flux. Uranium 233 is used as an enriching agent with natural uranium for fuel in other reactors.

The C.I.R. is a high flux (max. 6.5 x 10^{13}neutrons/sq. cm./sec.) slow neutron, heavy-water moderated and fresh-water cooled reactor using natural uranium as fuel and is designed to be operated at a maximum power level of 40 megawatts (thermal).

This paper describes, in general terms, the design and construction of the project; from the point of view of the civil, mechanical and electrical engineers engaged upon the task of interpreting the ideas of nuclear specialists in terms of conventional engineering materials and techniques suitable for employment in a relatively undeveloped tropical country.

THE DESIGN of the "pile" or reactor proper is based on Atomic Energy of Canada Limited's NRX reactor which has been in operation at Chalk River for the past ten years. The design of the rest of the Project, however, including the buildings, enclosures, cooling systems, air-conditioning and exhaust air plants, electrical equipment and auxiliaries generally, has been developed to suit the special requirements of the site and to permit the entire plant to be erected and maintained by the particular type of skilled labour available in India.

Building — The design of the building housing the reactor was dictated by the condition that in no circumstances should radio-active gaseous products be liberated into the atmosphere in the event of malfunctioning of the reactor. The C.I.R. is located adjacent to an area containing about 3 million people and in the extremely unlikely event that the reactor should be out of control, even temporarily, there must be no possibility of gaseous fission products escaping.

The pile and the storage block, i.e., the units containing the fissionable material, are, therefore, housed in a pressure-tight steel shell to which access can be gained only through ventilated airlocks.

The large diameter of the cylindrical vessel required (120 ft. 0 in.), dictated the adoption of the hemispherical dome as the only reasonable method of forming a true pressure vessel.

Reactor

Whilst it is, of course, beyond the scope of this paper to deal with nuclear considerations *per se*, the nuclear considerations which govern the design of experimental reactors generally must be kept in mind as they form the background against which all the "conventional" engineering problems must be viewed.

An experimental reactor is primarily a source of neutrons. The heat generated during the chain reaction producing the neutrons and the reaction occurring when neutrons are captured, is a necessary evil to be disposed of as unobtrusively and as efficiently as possible and is of interest only as a measure of the power level at which the reactor is operating. In a so-called power reactor, on the other hand, the pile is a source of heat and neutrons are of interest only in so far as they effect the heat-producing capacity of the pile and the amount of shielding required. The reaction is the same in both cases, it is merely the designers' points of view which are different.

The principal nuclear considerations governing the design of C.I.R., and all experimental reactors of this type, are as follows:

(*a*) Neutrons must be conserved and not wasted (i.e. not "captured").

(*b*) When certain materials enter an area of neutron flux radioactive isotopes are produced having varying intensities of radioactivity and varying "decay periods".

(*c*) Heat is produced in all reactions involving neutrons.

(*d*) Neutrons, gamma rays and other radiations associated with nuclear reactions are extremely harmful to organic tissue and every precaution must be taken to shield personnel and sensitive materials from them.

(*e*) Nuclear reactions progress rapidly and silently so that the instruments used to detect faults, measure quantities and indicate the state of a given process, and the equipment provided to act upon the signals given by those instruments must all respond with equal rapidity and must be automatic and reliable to a degree not required of equivalent apparatus used in other branches of engineering.

In the C.I.R. the nuclear reaction

takes place inside a cylindrical aluminum tank called the calandria. This tank is 8 ft. 9 in. diameter and approximately 10 ft. 6 in. high. It consists of a thin shell attached to end tube-sheets each about three inches thick. Into the tube sheets are expanded light vertical tubes through which the fuel rods, shut-off rods and experimental (loop) rods are inserted.

The calandria contains the heavy-water which acts as a 'moderator', slowing down the fast neutrons emitted by the U235 until they have only the so-called 'thermal energy' necessary to maintain the chain reaction. The fast neutrons are slowed down from speeds of 10,000 miles per second to one mile per second.

The power-level at which the reactor is operating at any time is controlled by varying the level of the heavy-water in the calandria. Shutting down the reactor is accomplished by "dumping" part of the heavy-water into prepared tanks below the pile and at the same time inserting into the pile what are called 'shut-off rods containing boron (which absorbs neutrons).

On C.I.R. provision has been made for 186 fuel rods with six additional positions into which either fuel rods or 'loop' experiments may be placed.

A fuel 'rod' consists of a long aluminum tube having a central portion, approximately the same length as the calandria, containing a cylindrical core of uranium 1.36 in diameter. The uranium is protected from the cooling water by a thin cladding of aluminum which is drawn down over the uranium core. An outer sheath of aluminum, separated from the core by a space 0.070 in. wide, forms an annular passage for the cooling water. The central "working" portion of the rod is attached to top and bottom sections which serves to conduct cooling water to and from the uranium section and provide shielding to the ends of the uranium core. The total length of the fuel rod is approximately 30 ft. 0 in. and the rod is handled in this length by a suspension device at its upper end.

Fuel rods are suspended in the pile from seatings formed at their upper ends which bear on bevelled shoulders in holes in a master plate at the top of the pile. The inlet ends of the rods seat against prepared sealing faces in a header assembly above the master plate. The bottom of the rods seal against similar faces on another header assembly below the pile and water is circulated through the fuel rods from the upper header to the lower header.

Having in mind a picture of the central core of the reactor in which the principal reaction takes place, attention can again be focused on considerations *(a)* to *(e)* above in so far as they affect the design of C.I.R.

(a) Neutrons which would otherwise escape from the sides of the calandria are returned to the core by a reflector. The reflector consists of two concentric hollow cylinders of graphite having an inner ring 9 in. thick, separated from the wall of the calandria by an annular clearance of 1½ in., and an outer ring 24½ in. thick separated in turn from the inner ring by an annular gap of 2½ in. Both rings of graphite are approximately 11 ft. 4 in. high.

In the 2½ in. annular gap provision is made for the suspension of up to 92 thorium rods to be irradiated by neutrons which have penetrated the inner, thinner, ring of graphite.

(b) The materials in the pile core must not absorb neutrons to any great extent and whilst aluminum and carbon do not have high 'capture cross sections' the impurities normally associated with these materials do have high cross-sections and besides absorbing neutrons they become highly radioactive in the process. For this reason special reactor grades of aluminum and graphite are used but their compositions are regarded as industrial secrets by the manufacturers.

Similarly, the cooling water and the heavy-water circulated through the pile must not contain impurities which will capture neutrons and thus become radioactive. The water in the cooling system is therefore treated before being charged into the system and continuously thereafter whilst the pile is operating.

The space above the heavy water in the calandria varies during operation and is kept filled with an atmosphere of helium which is not affected by radiation and does not combine with heavy water. Air is not permitted to come into contact with heavy water as it would be carried into the pile and be irradiated. Air would also downgrade the heavy-water by the contaminating action of the nitrogen compounds formed during the irradiation so that a helium atmosphere must be provided over the heavy water at all times.

(c) Of the 40 megawatts tota heat output of the pile approxim ately 38 megawatts are produced i the fuel elements themselves. Th maximum temperature of the urani um at the centre of a rod is ap proximately 977 degrees F., and th maximum temperature of the inne sheath is 239 deg. F. The coolin water enters the upper header at maximum temperature of 125 deg F. and leaves the lower header a approximately 175 deg. F.

The minimum temperature of th fresh water coolant, which circulate in a closed circuit through heat ex changers, is set by the temperatu of the sea-water used on the secon ary side of the system. The se reaches a temperature of 90 deg F. in the hot season and the min mum temperature to which the prin ary cooling circuit can be cooled u der these conditions is assumed to b 117 deg. F.

Primary cooling water is circulate at a maximum rate of 25 Imp. ga lons per minute per rod, making possible total of 5000 I.g.p.m. for th whole pile under full load condition The maximum pressure at the upp header is approximately 220 lb./ s inch. The pressure drop through th rod corresponding to a flow of 25 ga lons per minute is 135 lb./ sq. inc

The pressure at the lower head is 37 lb. per sq. inch, the balanc being the pressure-drop across an o ifice placed between the bottom the fuel-rod and the lower head for the purpose of calibrating an measuring the flow of water duri operation.

The reaction within the calandr produces heat in the heavy wat and so further heat exchangers a provided to dissipate a total of 20 kw. of heat from the heavy wate

Heat is also generated when ne trons and other radiations are sto ped by the shielding materials pr vided for the protection of personn as outlined below under *(d)*.

As the calandria tube-sheets a 3 in. thick it is not considered nece sary or practicable to install refle ors above and below the calandria, neutrons would have to pass throu the 3 in. aluminum plate twice a most of them would be captured the process.

To absorb neutrons and oth radiations escaping through the en of the calandria, devices called the mal shields are provided above a below the pile cord.

Immediately below the calandria is a shallow aluminum vessel consisting of a short shell and two heavy tube-sheets drilled for and provided with tubes through which the lower ends of the fuel rods pass. The vessel is called a removable thermal shield and rests in the centre of a fixed steel vessel of similar construction but of doughnut shape.

The inner aluminum section and the outer steel section of the shield are filled with water and the assembly forms a sandwich in which the water slows down the fast neutrons and the metal captures the resulting thermal neutrons and other escaping radiations.

Below the first section of the lower thermal shield are two more fixed shields of sandwich construction made from heavy steel plates. The object of using aluminum for one section is that if it should ever be required to remove it to gain access to the steel shield below, the high purity metal would not contain radioactive impurities having so long a decay period that handling the shield would be out of the question.

Above the calandria is a similar steel 'doughnut' fitted with a removable aluminum centre section and above this are steel 'doughnuts' having removable steel centre sections. All three of these water-cooled shields are fitted with tubes through which the fuel rods and other facilities can be inserted.

Two separate water cooling systems are used on the thermal shields, one for the steel shields and one for the aluminum shields. This is done to provide cooling-water having the correct anti-corrosion characteristics appropriate to the metals in the systems. Each system is further divided to the fixed and removable sections.

From the two aluminum shields a total of approximately 100 kw. of heat is removed and from the steel shields approximately 130 kw. This heat also is dissipated in heat exchangers using sea water at 90 deg. F. on the secondary side, thus the minimum temperature of the cooling water entering the aluminum shields is approximately 100 deg. F.

Water cooled shields are not provided at the sides of the pile to stop radiations which escape from the reflector graphite. Instead, two concentric rings of cast-iron, each 6 in. thick are provided, separated from each other by an annular gap of 2 in. and from the outer ring of graphite by an annular gap of 2 in. The cast-iron shields, the graphite and the J-rods are cooled by a stream of air which emerges from a circular duct below the cast-ion shields and passes upwards, through the annular spaces between the cast-iron rings and between the outer ring and the concrete construction, and then passes down between the concentric rings of graphite, over the J-rods and into a second duct concentric with the inlet duct and thence out to the exhaust air fans and the stack.

Openings are provided in the cast-iron thermal shields to accommodate the thermal columns, to be described later, but the annular air passages are maintained to facilitate the flow of cooling air over the cast iron and graphite surfaces.

(*d*) Whilst the water-cooled and cast-iron thermal shields effectively contain most of the neutrons within the pile, gamma rays and other radiations associated with the neutron capture in the thermal shields, are radiated from the sides of the shields. Further protection must be provided therefore to reduce the intensity and strength of the escaping radiations below what is called the biological tolerance.

The additional shielding is called biological shielding; it is made of concrete which contains sufficient hydrogen to slow down any fast neutrons and sufficient heavy material to capture slow neutrons and absorb secondary radiations.

The biological shield around the side of the pile consists of a wall of concrete 8 ft. thick, poured in position at the time of construction. Above the thermal shields, four steel trays are provided, each 12 in. deep, filled with reinforced concrete and fitted with vertical tubes through which the fuel and other rods can be inserted. These shields are supported on cast-iron webs embedded in the structural concrete and may be removed to gain access to the pile core.

To prevent neutrons from streaming out of the pile along the sides of fuel rods and other openings in the shielding, all holes are stepped and the rods, plugs and other inserts are similarly stepped so that there are, at all times, no direct paths along which neutrons may escape.

Below the lower thermal shields it is not considered necessary, or practicable, to provide biological shielding as the area is not accessible whilst the pile is in operation.

To guard against the effects of pos-

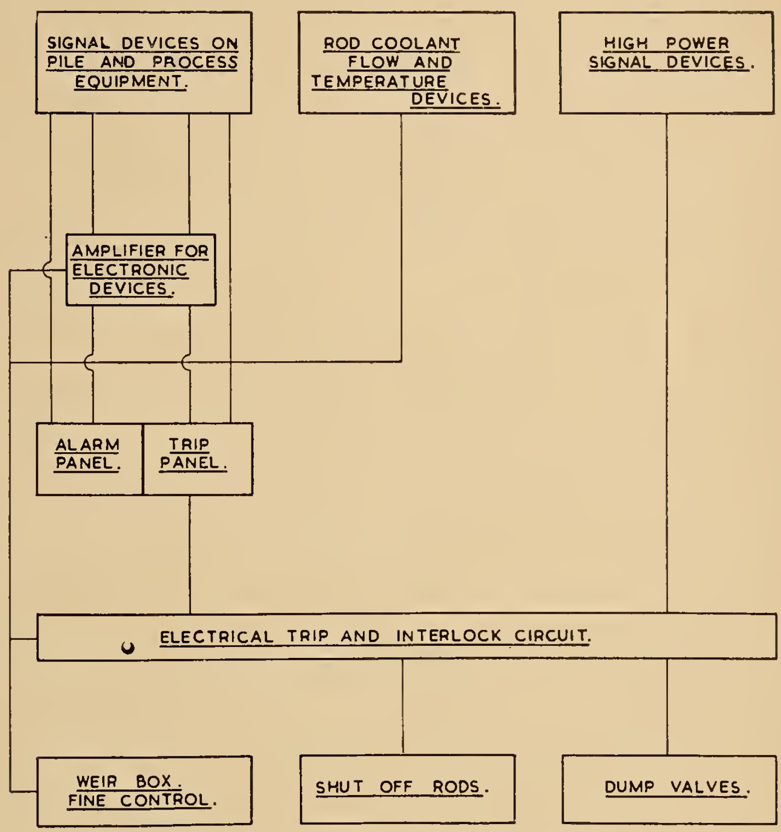


Fig. 1—Schematic arrangement of automatic safety control system.

sible radiations escaping from the tops of the shut-off rods and from fuel rods being removed from the pile, a final shield is provided in the form of a hollow floor at the top of the pile. The floor consists of a steel and water sandwich, similar in construction to the steel shields except that the water is not circulated because very little heat is generated.

The floor is circular and contains a concentric revolving centre section which, in turn, has a further revolving section within it but eccentric to the axis of the main turntable. The small inner turntable contains a hole over which the rod handling flask can be centred. By revolving the two turntables through predetermined angles the hole may be located over any rod position in the reactor.

(e) When the reactor is operating at full power a great deal of heat is generated in the components, as has been described, and adequate cooling capacity must be available at all times. If the reactor should be allowed to start with inadequate cooling available, or if it should be allowed to exceed the rated power with only normal cooling capacity present, then serious damage could result.

To prevent the reactor from starting if an unsafe condition exists and to shut it down if an unsafe condition develops during operation, the reactor and its auxiliaries are provided with an automatic safety control system. The system is shown diagrammatically in Fig. 1.

The two principal devices in the automatic safety control systems are:

(i) Shut-off rods

(ii) Dump valves.

The shut-off rods are considered the primary protective devices and are designed to "trip" or shut the reactor down quickly. The dump valves permit the heavy-water in the calandria to fall rapidly from the maximum level of 307 cm. to the 150 cm. level, giving supplementary shut down at a moderate rate.

The automatic safety control system is a very involved one, designed to fulfil the requirements that the reactor be started-up, operated and shut-down safely. Information from various signal devices is fed into an electrical trip and inter-lock circuit which interprets the information and actuates the principal control devices.

The automatic safety control system is also designed so that operational mistakes will not contribute to disastrous consequences.

To protect the reactor from the effects of faulty instruments and defective circuits, signals are divided into two types, trip signals and alarm signals. Generally, three signal devices are provided to indicate a particular type of fault or condition; a signal by one device alone will actuate an alarm signal which may be a visual or an aural device, but a signal from two out of the three instruments will actuate a trip and an alarm signal.

Trips are further subdivided into two types — conditional trips and absolute trips:

Certain trip signals are 'conditioned' by low-power measuring devices as follows:

(i) The trip signals result in a shut-off rod release and heavy-water dump if the power is above one per cent of full power, e.g., when the pile is shut down and some of the shut-off rods are raised.

The principal reason for operating at less than 1 per cent power is to keep the reactor from "poisoning out" while troubles are being corrected.

Absolute trips result in the release of all the shut-off rods and the dumping of heavy-water in both the low and high power stages. Absolute trips prevent shut-off rods from being raised or the heavy-water dump valves being closed if the equipment is not in good working condition. Absolute trips also prevent shut-off rods from being raised when the pile is at low power stage with heavy-water in the calandria if the shut-off rod mechanisms are in any way faulty and cannot be re-lowered.

All signals actuated by high-power devices give rise to absolute trips, even if the signal results from faulty equipment (conditioned, of course, by the 2 out of 3 coincidence system) as it would be hazardous to operate or even to start the pile with high power devices unserviceable.

All the safety control devices are designed to "fail-safe" so that, as far as possible, failure of the equipment will not prevent the control device from operating. For example, the calandria dump - valves are held closed by compressed air and are opened on the release of the compressed air by powerful springs, so that in the event of an air failure the valves would automatically open and the pile would shut down. The shut-off rods are similarly designed so that they are raised mechanically, but lowered automatically by the action of gravity aided by springs which accelerate the rods into the pile with high velocity.

In setting up the reactor safety control circuits, the following items were among the most important considerations.

(a) The maximum power level at which the reactor may be operated is governed principally by the ability of the cooling system to remove the heat produced. If the power level should suddenly rise above this maximum, then the pile must be shut down. As the power may rise almost instantaneously, measurement of thermal output to the cooling system is inadequate for safety control due to the time lag in temperature measurements. Therefore, ionization chambers which produce an instantaneous electrical signal directly proportional to neutron flux (power level) are used for safety control. One group of ionization chambers located in the thermal column is used with appropriate electronic amplifiers for automatic reactor control. Trip signals for overpower and excessive rate of rise of power are obtained from these amplifiers. In addition, a second group of ion chambers placed in a different position in the reactor are used for back-up protection on high power. These chambers are connected directly to sensitive relays with no intervening amplifiers so as to reduce the possibility of "no trip" due to instrument failure.

Ion chambers are very sensitive to neutron flux changes but they do not provide a sufficiently accurate measurement of the thermal power of the pile. For fine control of the reactor during normal steady-state operation, the ion chamber signal is automatically compensated by measurements of the temperature rise of the cooling water, thus giving a more accurate indication of the power output.

(b) Failure of the main electrical power supply, which would cause circulating pumps, air - conditioning plant, compressors, etc., to stop, must also give rise to an absolute trip and this is accomplished by relays actuated by the power-circuit itself.

(c) In certain circumstances a fuel rod may become distorted, causing the inner protective sheath to split. This would result in radioactive fission products being released into the cooling system and portions of the sys-

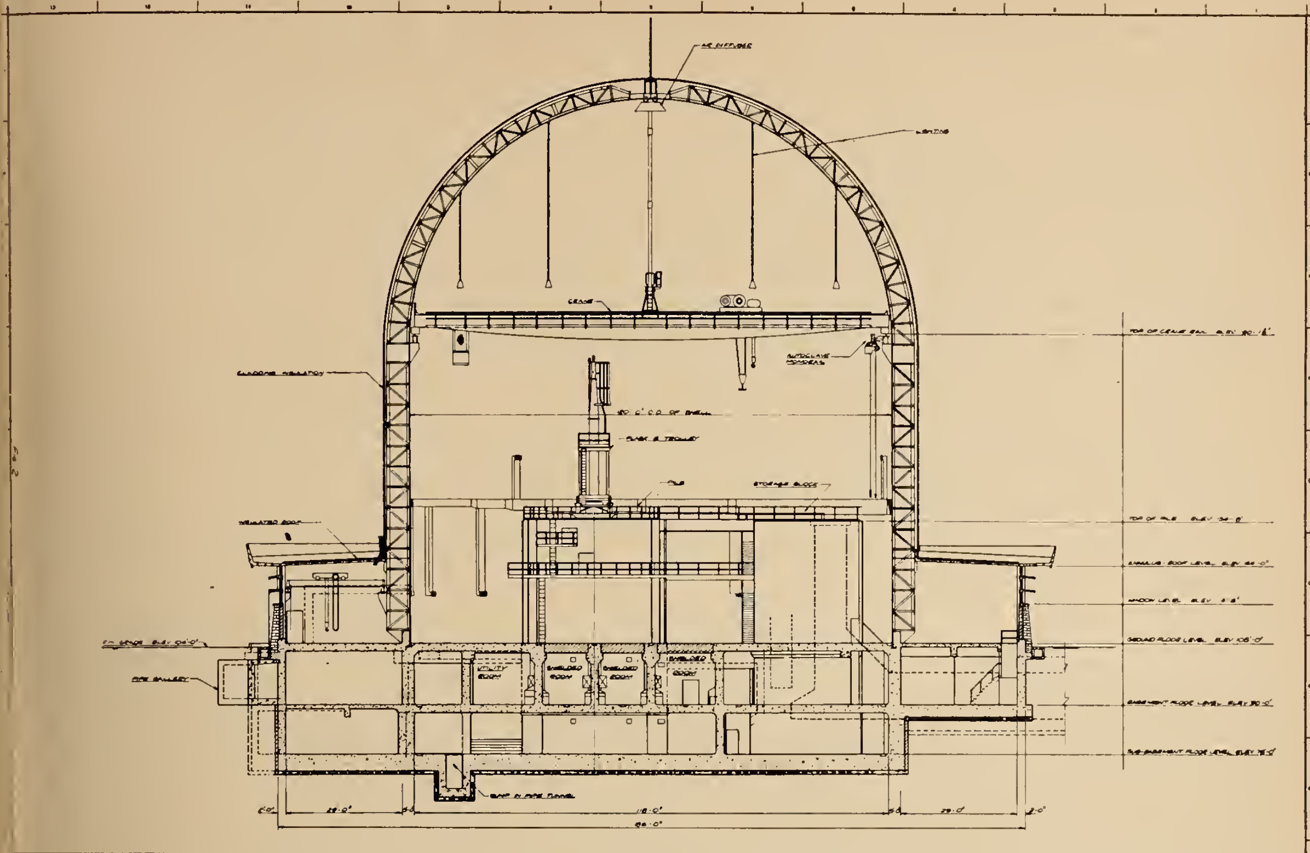


Fig. 2—Cross section of reactor hall and annulus.

em would become contaminated.

When this occurs, a radiation de-ector trips the pile, stops the main umps and transfers the cooling to n emergency system which carries ie contaminated water into a large ump tank.

A device called a gaseous fission-roducts monitor is provided to sam-le the cooling water as it emerges om the bottom of each fuel rod. he gaseous fission products will es-ipe to the cooling water before an tual rupture of the sheath occurs. hese radioactive gases are detected v this monitor in the following way: A sample of water is passed rough a 'stripper' unit, where air bubbled through it to strip out the iseous fission products for passing a beta counting head.

If the beta activity in the gas pass-a certain predetermined level, an irm is sounded and the split rod identified on an annunciator pan- in the control room. With the uipment provided it will be pos-ble to set the alarms so that a rning may be given before the ac-ity reaches a dangerous level, thus rmitting removal of the damaged l and preventing contamination of t cooling system.

(*d*) Failure of important auxiliary equipment which might lead to dangerous conditions on the pile or to health hazards to personnel will also trip the pile.

In addition to failure of the main cooling pumps, as outlined above, failure or malfunctioning of the heavy - water pumps, sea - water pumps, or the air supply and exhaust fans will also trip the pile. High or low pressure, beyond the normal range of the cooling water at the bottom of a fuel rod will also actuate the trip and alarm circuit as an indication of a fault affecting the flow of water through that rod.

Instruments connected to all parts of the process and mechanical equipment will, on a fault being detected, transmit signals capable of actuating trips or alarms or both, depending upon the nature of the fault and the importance of the equipment in question.

Pile Construction

To ensure that the pile could be erected in its final location at the site without recourse to heavy machinery and other equipment for final adjustment, it is designed for pre-assembly at the plant of the manufacturer in Canada. Dummy fuel rods are provided to test the dimensional accuracy of each and every hole in the assembly.

The pile proper is carried on a heavy steel frame consisting of a machined assembly of welded plates and shapes supported on four heavy steel columns. On the supporting frame, the main floor plate of the reactor is fitted; this is a steel plate 6½ in. thick, 18 ft. 0 in. diameter. The floor plate supports the lower thermal shields which, in turn, support the calandria and the graphite reflector.

The main floor plate also supports the cast-iron side thermal shields and the peripheral ducts through which cooling air is supplied to and removed from the pile.

The upper thermal shields are supported by the shielding concrete surrounding the pile and by a steel structure provided to facilitate assembly; these support also the cast-iron webs into which the four removable biological shields are fitted and on which the 4 in. thick top master plate rests.

The top master plate is provided with the holes having bevelled shoulders on which the fuel and other rods are suspended in the pile. The master plate positions the rods at the correct spacing in the pile as determined by the characteristics of the reactor.

The upper cooling water header is supported by saddles on the master plate and is free to move radially as the four supply nozzles to the feed pipes are connected through expansion joints.

A cylindrical steel shell supporting the revolving floor above the pile, forms the upper header room which contains the upper ends of the fuel rods, the driving mechanism for the shut-off rods and, of course, the upper header itself.

The upper header room is connected to the shielded rooms by vertical chases in the shielding concrete. At the base of the pile the space beneath the main floor plate is called the lower header room and it also is connected to the shielded room by chases in the concrete.

The chases permit the pipes of loop experiments to be brought, from the ends of the assemblies in the piles, to the equipment set up in the shielded rooms.

The materials used in the steel shields, the top master plate, main floor plate and revolving floor are standard low carbon steels selected for weldability. To avoid cracking and to secure sound welds, low hydrogen electrodes are used and the completed weldments are stress-relieved, before being machined, to prevent distortion.

The cast-iron side shields are of ordinary gray cast-iron, also stress-relieved before being machined to prevent distortion.

Wherever possible, standard materials are used and the manufacturing tolerances are kept as open as possible in order to keep the work within the range of good industrial practice.

In the past, attempts have been made to build reactors with a high order of precision, but experience with the NRX reactor has proved that the advantages of close tolerances are, in many cases, more apparent than real — even when they are attained in practice which is not quite as often as might be expected.

A feature of the upper thermal shields is the provision for removing tubes from the calandria without removing the upper shields. By mounting a heavy drill on top of the pile and drilling downwards, using a special technique developed by A.E.C.L. at Chalk River, it is possible to remove and replace damaged calandria tubes without dismantling the reactor.

In the removable steel shields the tubes have extra thick walls to permit them to be bored out, to allow a calandria tube to pass through, without seriously weakening the shield. The tubes in the aluminum shield above the pile and the tubes in the removable biological shields are made large enough to pass the calandria tubes without drilling.

Experimental Facilities

Another important design consideration is the provision of experimental facilities in the pile which will permit the maximum possible use to be made of the high flux available.

The experimental facilities include the following:

(*a*) Thermal columns.
(*b*) Horizontal holes.
(*c*) Vertical holes.
(*d*) Self - serve holes.
(*e*) Central experimental hole.

(*a*) The thermal columns are used to obtain thermal neutron beams of high purity and large cross-sections; they are projections of the graphite reflector which extend horizontally through the shielding on the east and west axes of the reactor.

Each column consists of a stationary and a removable section of graphite. The stationary section is 5 ft. 0 in. square and extends from the reflector graphite to a point immediately outside the cast-iron thermal shields. The removable section extends to the outside of the shielding concrete and is separated from the fixed sections by a slot left to complete the cooling-air annulus between the two sections of the side thermal shields.

The removable section of the column is divided into three assemblies of graphite blocks, mounted on shallow-four-wheel trucks so that they may be removed from the reactor. The three movable assemblies are each 2 ft. 6 in. thick and 6 ft. 8 in., 6 ft. 3 in., and 5 ft. 10 in. square respectively.

The four sides of the thermal columns are enclosed by a cast-iron frame, 12 in. thick at the inner end of the movable section and diminishing by steps to 3 in. at the outer end. A clearance of 3/16 in. is provided between the movable sections and the cast-iron frames to allow passage of air. The cast-iron frames serve to support the weight of the removable sections and to protect the surrounding concrete from the damaging effects of radiations.

The graphite blocks in the removable sections are each 6 in. x 6 in. x 30 in. and certain pieces may be removed to vary the intensity of the neutron beam desired. A central block may be removed forming a hole extending all the way to the calandria shell and other blocks may be removed to form openings of various sizes.

The outer face of each thermal column is covered with a large vertical sliding door of lead and steel having a thin layer of cadmium on the inside surface. A small door, sliding in grooves in the main door, is also provided.

In the east thermal column are located the ion chambers for power measurement and steady-state operating control of the pile.

(*b*) The horizontal holes extend from the outer face of the biological shielding concrete to the calandria shell. Each hole has a cast-iron inner door, which operates like a large plug-cock, located on the inner face of the biological shield. The gate is operated by a worm-drive shaft which extends to the reactor face. The outer end of each hole is provided with a lead gate operated by a hand-screw located on a cast-iron housing at the reactor face. Through these gates and doors equipment can be inserted into the pile without exposing personnel to excessive radiation.

The horizontal holes include the following:

(1) Twenty - nine experimental holes 4 in. diameter.

(2) Five experimental holes 12 in diameter.

(3) Fourteen experimental holes 8 in. diameter; four of which contain the ion chambers actuating the low and high power trips for pile control whilst the remaining twelve are available for future instrumentation or experimental purposes.

(4) Four horizontal holes 2⅝ in diameter carrying temperature and pressure measuring instruments located in the J-rod annulus.

The experimental holes provide means of irradiating a few large samples or of obtaining neutron beams external to the reactor. The 'holes' consist of stepped holes extending through the reactor structure to the face of the calandria. They are lined with aluminum tubing in the graphite reflector and with steel tubing in the cast-iron thermshields and in the biological shields.

When not in use for experimental purposes, the holes and plugs are cooled by a stream of air drawn into the J-rod annulus through the annular space around the plugs. When samples are being irradiated, however, additional cooling may be required and special arrangements are made to suit each particular experiment.

When the horizontal holes are not actually containing instruments or experiments, they are filled with temporary wooden plugs fitted with end sections of lead and cadmium; soft wood is used for this purpose as it forms satisfactory shielding and is relatively inexpensive.

(*c*) Six vertical holes are provided in the calandria, each having a diameter of 4 in. into which either standard fuel rods or loop experiments may be placed. In a loop experiment, test equipment is located in one of the shielded rooms and the material under test is circulated from the shielded room, through the pile and back to the shielded room. When these holes are used to contain normal fuel rods, special sleeves are provided in the upper thermal shields to reduce the size of the holes so as to prevent streaming of neutrons past the fuel rods.

(*d*) Six self-serve or sample units are provided, each fitted with a five-receptable plug, thus permitting a total of 30 samples to be irradiated at the same time.

The self-serve holes provide a principal means of producing radioactive isotopes. They are designed for the irradiation of small samples in the region of the graphite reflector and close to the calandria shell. The samples must be capable of enclosure in a 2¼ in. diameter aluminum sphere as they are allowed to roll to the carrying plug for insertion and to roll out to sample flasks for removal from the pile.

The units are provided with electrical and mechanical interlocks to prevent the insertion of more than one sample in one position and to avoid exposure of personnel to irradiated samples. They are so designed that the special shielded sample flasks must be in position at the discharge holes to receive samples before the carrying plug can be unlocked and the sample released.

(*e*) The central experimental hole in the pile, called the central thimble, is 5½ in. diameter and is available for use where high neutron density and a high proportion of fast neutrons are required, and where a relatively large sample or experimental assembly must be accommodated.

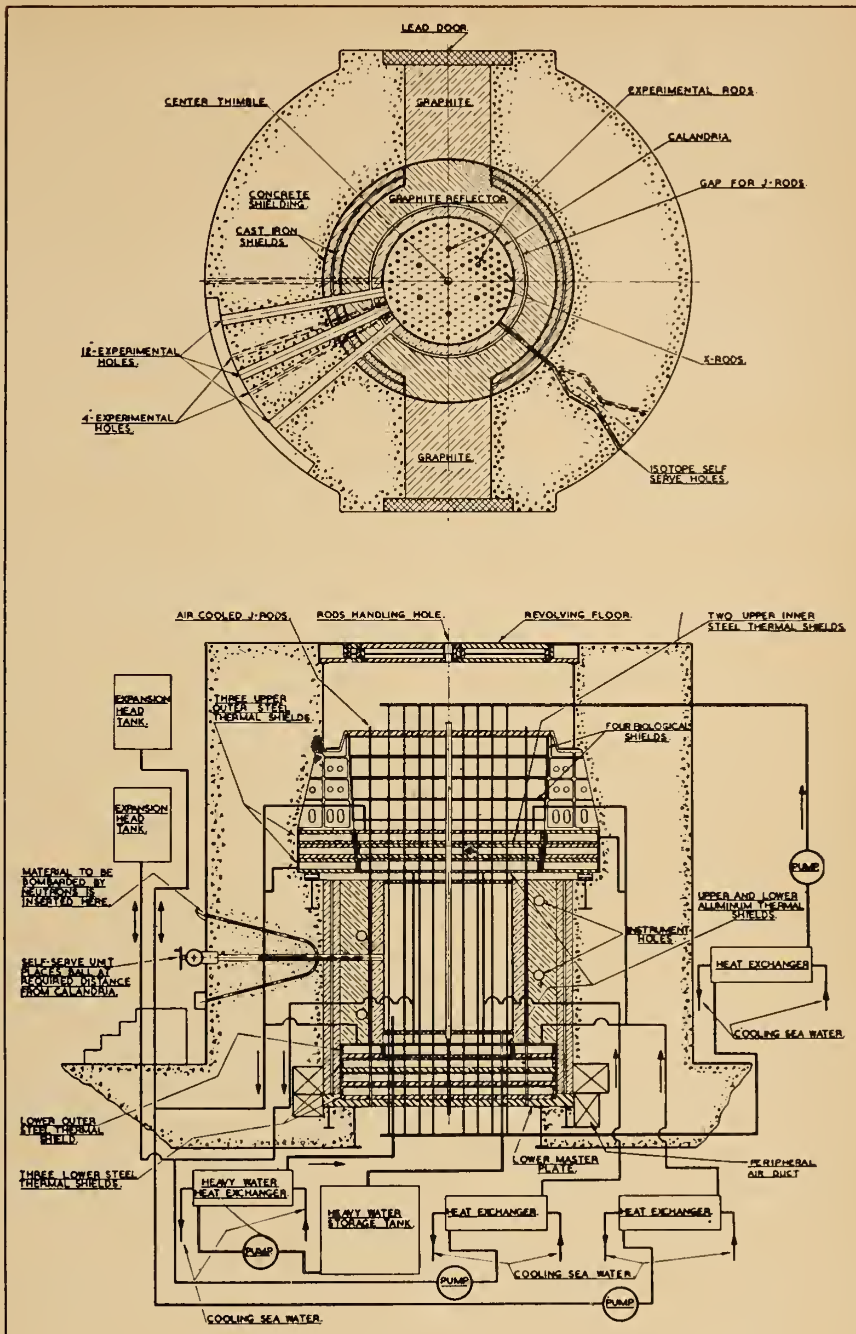


Fig. 3—Schematic diagram of reactor core and ancillary equipment.

This tube, when not in use, is also provided with a stepped plug (of steel) and the facility is cooled by air drawn from the process air system at the rate of approximately 90 cubic feet per minute.

Loop experiments of large size are also placed in this central thimble and connected to shielded rooms as described above.

The pile is also provided with a number of smaller holes and facilities for special experimental purposes, but the bulk of the work to be done with this reactor will be carried out on the facilities described above.

Rod Handling and Storage Equipment

As has been described, fuel rods are charged into the pile and discharged through a hole in the revolving floor. Whilst it is possible to lower a new fuel element into the pile by any convenient means, it is quite impossible to handle a spent or partly spent element in this way because the uranium section is so highly radioactive that exposure to personnel would result in death or serious injury.

All rods are, therefore, moved into and out of the pile by means of a vertical flask. A flask consists of a steel tube surrounded with sufficient lead to effectively stop any radiations from a fuel rod — even in its most dangerous condition.

The flask is mounted on an electrically driven carriage, and a portion of it is capable of being raised or lowered so that it can be positioned close to the pile floor to receive or discharge a rod. It can also be traversed across a bridge, shown in Fig. 2, to the storage block where rods can be discharged to or removed from storage.

The flask is designed to handle the central thimble plug and also a special adaptor for enclosing ruptured fuel rods and removing them from the pile. It is provided with manual hoists for raising and lowering the rods and with other facilities and flexible connections to permit them to be cooled after they have been removed from the pile.

Electrical and mechanical interlocks and other safeguards are provided to prevent fuel rods being removed when the flask is not in close contact with the floor and when personnel are in the upper header room.

The procedure when removing a rod is as follows: The pile is shut down to permit an operator to enter the upper header room for the purpose of disconnecting the normal cooling water supply and connecting a flexible hose from the flask above. At the same time, a flexible hose is connected to the lower end of the rod so that cooling interruption is kept to a minimum. The operator then leaves the upper header room to a point where a key must be inserted in the interlock system before the fuel rod can be raised. The rod is raised into the flask and the temporary hose from the lower header room is disconnected; a hose from the storage block is then connected to maintain the circulation of cooling water whilst the flask carriage is moving to the storage block.

New fuel rods are stored in racks in the area adjacent to the storage block and are transported to the storage block by the monorail for loading into the flask.

Spent fuel rods are stored under water in a tank in the storage block. There they are left for several months to permit radioactivity to decay to the point where they may be further treated.

After a short period of storage in the full length condition, the rods are placed into an automatic sawing machine built into the storage block. This machine cuts off the portions above and below the uranium centre section and then strips the outer sheath from the remaining section of the rod. The uranium section, with its thin aluminum cladding, is then transferred to the wet storage tank until such time as it is desired to remove it for further processing.

The upper and lower sections of the rods are removed, and after cleaning and decontaminating they are re-used on other fuel rods,

The storage block contains also the following additional facilities:

(i) Horizontal holes for storing plugs and experimental assemblies from the horizontal holes in the pile.

(ii) Vertical holes for storing central thimble plug and ruptured rod flask.

(iii) X-ray equipment for radiographing irradiated fuel elements,

(iv) Facilities for loading and unloading samples in special 'tray rods'. These are used to irradiate small samples in fuel rod positions for the production of radio isotopes.

(v) Trench system connected to outside water-filled cutting bay for cutting and dismantling loop experiments.

Layout of Reactor Hall Rotunda

The general arrangement of the reactor building is shown in Fig. 2. The central rotunda contains the steel pressure shell, housing the pile and the storage block. The lower, annular, single storey building at the base of the rotunda contains all the auxiliaries and services not actually required at the pile itself.

The rotunda stands upon a reinforced concrete substructure, consisting of a basement and a sub-basement founded upon rock; the annular building stands upon a similar substructure, but has for the most part only a single basement.

The rotunda consists of a heavy steel framework supporting, on the inside, the plating of the steel pressure shell and covered on the outside with insulating material and the outer cladding of the architectural treatment. The cylindrical shell plate is ⅞ in. thick and the dome plate is ½ in. thick, these thicknesses being necessitated by practical considerations rather than by pressure requirements.

The design pressure for the shell is 5 lb./ sq. in. above atmospheric and under this pressure the shell will be stressed to only about 4.5 kips per sq. in.

The shell is constructed of low-carbon steel to A.S.T.M. Standard Specification A285 Firebox Quality Grade C. The welding electrodes used are low hydrogen electrodes to AWS Classification E7016. The field welding is subject to 100 per cent gamma ray inspection.

The ribs are designed for assembly with bolts of high tensile steel. In addition to the dead load of the structure, they support the 30-ton revolving crane inside the rotunda and the roof of the annulus building outside.

As there is a general uncertainty regarding the magnitude of the pressures which might develop within the reactor shell, in the event of a temporary uncontrolled power rise, the structure is designed for a nominal pressure of 5 p.s.i. above atmospheric, but the working stresses are selected so that a pressure rise of 30 p.s.i. will be required to produce serious deformations in the shell and substructures. In the case of the substructures, this is made possible by back-filling with concrete between the walls of the basement and the rock excavation.

Figure 3 shows the layout of the equipment on the main floor of the rotunda; the principal items here are the pile block and the storage block. The floor at this level is provided with covered channels connected to a peripheral channel at the base of the shell, for the accommodation of temporary wiring and other services to instruments and experiments which may be set up around the pile block and round the periphery of the building.

In the experimental area around the pile, provision is made for experiments involving equipment and lead shielding equivalent to a superimposed loading of 6,000 lb. per sq ft. Elsewhere, this floor is designed for a loading of 3,000 lb. per sq. ft

In the main floor also are removable slabs which form the roofs of the shielded rooms in the basement below. Eight of these shielded rooms are provided, where loop experiments can be set up in which fluid may be circulated through the pile and through experimental equipment in the rooms, in such a manner that highly radioactive materials may be handled without danger to staff.

The rotunda can be entered only at this floor level, through the personnel and the vehicle entrances. Both entrances are fitted with airlocks approximately 25 ft. long inside; tional king-post, the problem of centring the crane is solved by attaching a heavy roller elevator-bucket type chain to the crane rail girder. The chain is arranged so that the rollers form horizontal rack teeth on a circular path parallel to the crane rail. Sprockets with horizontal shafts, geared to the drive wheels at each end of the crane, engage the rack pacity of 1,000 lb. This monorail will be used to handle new fuel elements which are either under construction or being tested prior to insertion in the pile.

In the basement are situated, in addition to the shielded rooms, a utility room for the use of maintenance and other personnel; a monitoring room containing flow monitoring

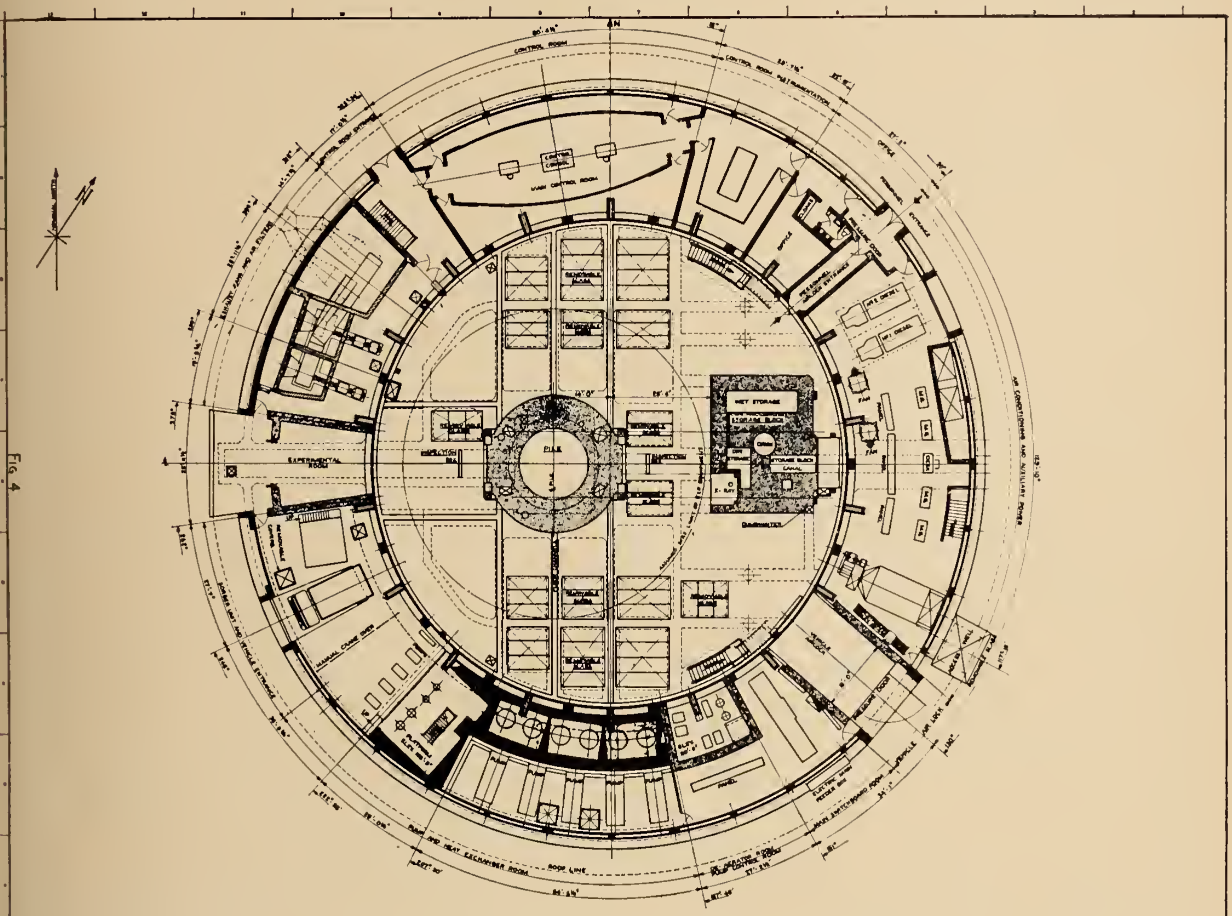


Fig. 4—Ground floor plan of reactor hall and annulus.

to permit all forms of normal traffic to enter and leave the reactor hall without violating the principle of maintaining a pressure-tight shell at all times. The two doors in each entrance are interlocked to prevent more than one being opened at the same time and the power supply to all the doors in the entrance will, in an emergency, be controlled from the main control room in the annulus building.

The reactor hall is serviced by a revolving crane having a 30-ton capacity main hoist and a 5-ton capacity auxiliary hoist. As the hemispherical dome of the rotunda is too high to permit the use of a conventeeth and ensure equal angular motion of the end trucks about the centre-line of the crane.

The crane is fitted with normal hoisting, lowering and holding brakes and all the movements, both vertical and horizontal, are at standard speeds; except that the 5-ton auxiliary hoist is provided with a secondary drive to permit hoisting and lowering at a speed of 1 foot per minute, when necessary, to handle fuel elements, experimental equipment, and so on.

In one sector of the building, a light monorail is attached to the crane rail beam to accommodate an electric monorail hoist, having a caequipment from the fuel rods and a room containing the heavy - water heat exchangers which must of necessity be placed close to the pile in order that the pipe-runs may be limited to conserve the amount of heavy-water required.

The sub-basement contains ventilating and air-conditioning ducts, power and instrumentation cables and service piping generally and will not be used for experimental or similar purposes.

The main floor of the annulus building is at the same level as the main floor of the rotunda and contains the control room, the vehicle and personnel entrance airlocks; air-conditioning plant; the main fresh water cooling pumps, the power supply distribution board and battery room; the motor control centre; the helium purification plant, together with part of the water treating plant and an experimental room in line with the west thermal column.

The area containing the main-pumps and heat exchangers is serviced by a 10-ton crane having electrical hoisting machinery and manual traversing movements.

In the basement of the annulus building, the heat exchangers are situated below the main pump room and the centrifugal compressors of the air - conditioning plant are located below the air-conditioning unit. The heavy-water tanks, heavy-water pumps, and the helium gasholder are located below the helium purification unit. In the room beneath the control room all the leads and wiring connected to the process and other instruments are collected on trays and lead up to the panel boards and console in the control room and to the trip and alarm panel in the room adjacent to the control room.

The basement also contains the ion exchange columns and deaerators of the water treating plant, together with the compressed air plant, main exhaust fans, air filters and the access chambers leading to the filter compartments.

Adjacent to a pipe tunnel on the west side of the rotunda basement is a small sub-basement under the annulus, containing the heavy-water salvage tank and catch tanks for the shield cooling systems.

The pipe tunnel is the primary means of access, through which the piping of the cooling circuits is led to the reactor. This tunnel is designed to be completely sealed off after all the pipes are in place in order to maintain the basement in a pressure-tight condition.

Details of Cooling System

As mentioned above, sea-water is used for cooling the reactor. Fresh water is circulated through the pile and the water - cooled shields in closed circuits and transfers heat to sea-water in heat exchangers located in the annulus. The heavy-water circulates in another closed circuit and is cooled directly by sea-water in heat exchangers located in a shielded room in the basement adjacent to the pile.

The primary cooling system has six heat exchangers arranged so that any number can be operated together in parallel. Under maximum normal operating conditions there are five units operating and one on standby.

The pumping plant for the primary cooling system consists of five horizontal centrifugal pumps each having a capacity of 1200 I.g.p.m. against a total head of 560 feet. These pumps have cast-iron bodies and bronze impellers.

The steel and aluminum shield cooling systems each consists of two heat exchangers, one operating and one on standby.

On the heavy-water system there are three heat exchangers arranged so that any number can be operated together in parallel; the system is designed so that two units only are required for the maximum operating conditions with one unit on standby.

The pumping plant for the heavy-water system consists of two circulating pumps each having a capacity of 250 I.g.p.m. against a total head of 162 feet; and two supply pumps each having a capacity of 50 I.g.p.m. against a total head of 76 feet. The pumps are horizontal centrifugal type made of stainless steel. The supply pumps are used for transferring heavy-water between any one of three storage tanks and the calandria or from one tank to another. Full standby capacity is provided as only one supply pump and one circulating pump are required for normal operation.

One of the storage tanks is in the circulating system and remains empty whilst the reactor is running at full power. The tank forms part of the line and the heavy-water merely flows through it. When the pile trips, the dump valves open and the heavy-water is literally "dumped" into this tank which then holds the requisite amount to shut down the pile.

During start - up, control valves on the discharge lines from the calandria to the tank are closed and the circulating pumps transfer heavy-water to the calandria at the rate of 250 g.p.m. for the purpose of rapidly bringing the pile up to the required power level. When this level is reached, the control valves are automatically opened so that the pumps then circulate the heavy - water through the cooling system, regulating the power output by the level in the calandria.

For what are termed "critical height" experiments, control of the level of heavy-water in the calandria is maintained by the overflow of heavy-water through a wire box which can be raised or lowered accurately to any height depending upon the power level at which the reactor is required to operate.

All valves, pipes, pumps and tanks in the heavy-water system are of stainless steel, to ensure absolute freedom from corrosion and consequent contamination of the system by irradiated corrosion products.

All heat exchangers are of the shell and tube type and are mounted vertically with floating heads at the lower end of the tube bundles. All the heat exchangers are arranged so that the tube bundles can be removed without dismantling the shells and in each set of identical exchangers the tube bundles are interchangeable.

In all cases, the sea water passes through the tubes, which are ¾ in. diameter and straight to facilitate cleaning. The sea water is chlorinated at the intake to inhibit the formation of marine growths. Experiments carried out near the site indicated that chlorine injected continuously in sufficient quantities to provide a residual chlorine content of 3 p.p.m. one half hour after injection would prevent serious fouling by marine growths under the most adverse monsoon conditions.

One of the problems in the design of the heat exchangers was the selection of suitable materials. The sea water carries a heavy silt load which has an erosive action if the water velocities are too high; on the other hand, if the velocities are too low the exchangers will silt up and fouling of the tubes will proceed at an accelerated rate.

On the fresh water coolers 70:30 copper nickel alloy is used for all the tubes and tube sheets and the sea water velocities are restricted to a range of 3 to 6 feet per second. For heads, channels and other fabricated parts in contact with sea water, silicon-bronze is used.

In the heat exchangers on the primary cooling and on the steel and aluminum shield cooling systems using fresh water, the shells are of copper - bearing corrosion - resisting low carbon steel.

The heavy-water coolers presented a more difficult problem as it was felt advisable to avoid copper and copper alloys in the heavy-water system. These heat exchangers are fitted with duplex tubes, having 70:30 copper nickel on the sea water side and type 304 stainless steel on the heavy-water side. The stainless steel outer walls of the tubes terminate in type 304 stainless steel tube-sheets and the copper alloy inner walls are secured in tube-sheets of 70:30 copper nickel. The double tube-sheets at each end of the exchangers are separated by air gaps and spacer rings of "Inconel" are provided and drilled to permit leak detecting probes to be inserted between the tube-sheets.

In the special heavy-water coolers, the heavy-water is exposed only they are insulated by means of Neoprene gaskets and the bolts securing the dissimilar metals are provided with insulating sleeves and washers.

The upper and lower headers and the supply pipes embedded in the pile concrete are of stainless steel. Stainless steel has been selected for the headers because mild steel will rust on the outside in the moist conditions created by leakage of water from the rod connections and contamination of the rusty headers times, a storage reservoir is provided of sufficient capacity to supply cooling water to the pile in an emergency for approximately four weeks with the pile operating under shutdown conditions.

Delay System

Although the cooling water is continuously treated during pile operation to remove impurities, certain isotopes having very short half lives are produced. To prevent a danger-

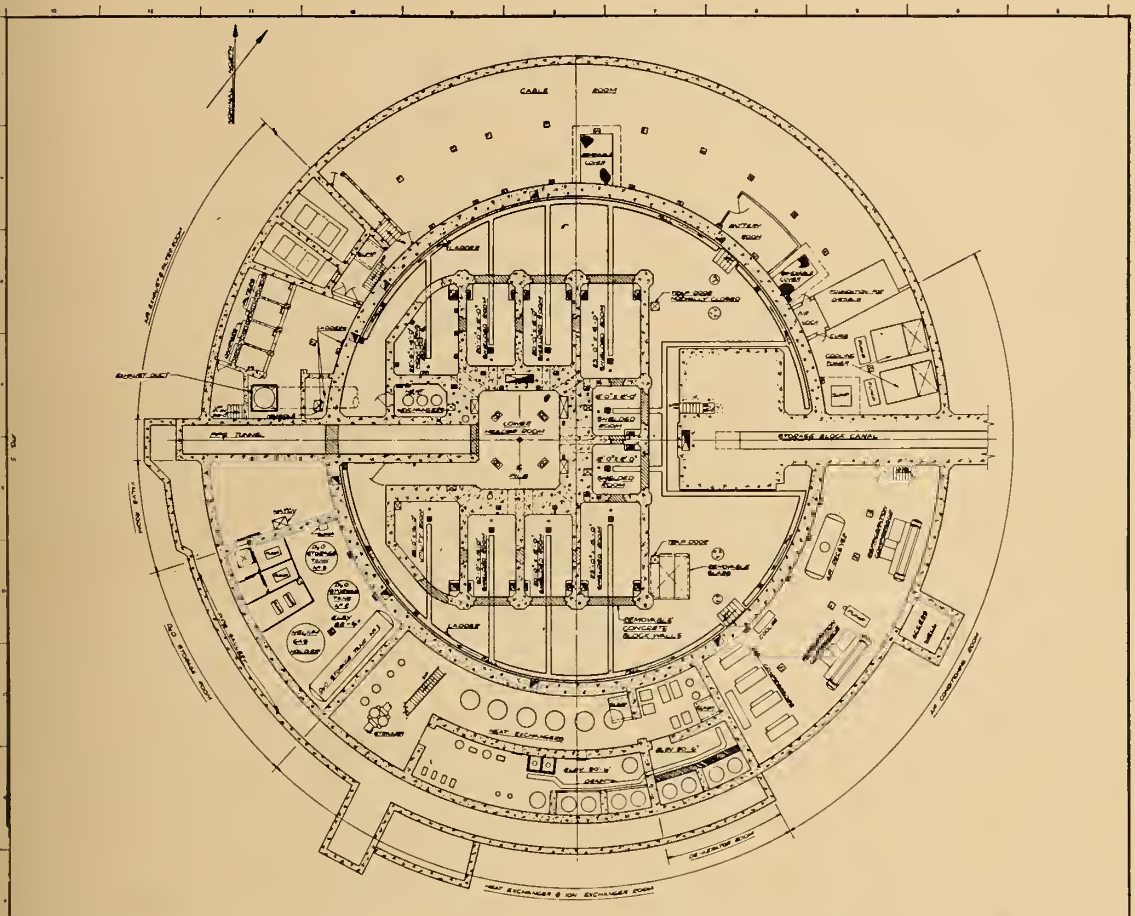


Fig. 5—Basement plan of reactor hall and annulus.

to stainless steel and the sea water to 70:30 copper nickel or to silicone bronze. No dissimilar metals are connected together in the presence of a common electrolyte so that galvanic corrosion will not be a hazard.

On the fresh-water coolers the sea-water is exposed only to 70:30 copper nickel alloy and silicon bronze and the fresh-water is exposed to the copper alloy tubes and tube sheets and to the corrosion-resisting steel in the shells. Where dissimilar metals are connected together in the presence of a common electrolyte, would make maintenance difficult. The embedded pipes are of stainless steel because they are totally inaccessible for maintenance after the pile concrete has been poured.

Type 347 stainless steel is used for the headers to permit them to be given a thermal stress-relief treatment during manufacture. Type 304 stainless steel is used for the embedded supply pipes.

Fresh water for the closed circuit main cooling system is supplied from the city water mains; but, as the city supply is not dependable at all ous build-up of activity in the cooling water, a delay system is provided to permit the cooling water to remain outside the pile for a pre-determined length of time.

This delay system consists of a 5 ft. diameter pipe 800 ft. long, in the form of a large 'U' (to save ground space). The pipe has a capacity of one hundred thousand gallons, thus providing a delay of 20 minutes with a flow of 5000 g.p.m.

The delay pipe is located at the foot of a nearby hill, directly under the storage reservoir. The entire system of delay tank and connecting pipes slopes upwards away from the pile to provide positive drainage when required and positive venting at all times. The system is vented through an open standpipe which also maintains a constant head on the low pressure side of the cooling system.

Twenty-inch diameter mild steel pipes connect the delay pipe to the pile; the delay pipe itself is constructed of low alloy corrosion-resisting steel (U.S.S. Corten).

Normal flow of cooling water is from the pumps to the fuel rods, through the delay tank, through the heat exchangers and back to the pump suctions, thus providing a total delay of a little over half an hour.

Water Treatment Plant

Water for the primary cooling system is initially charged into the system by feeding city water through a vacuum deaerator and a demineralizer bed until the system and the storage reservoir have been completely filled. During operation, approximately 100 gallons per minute is fed through the vacuum deaerator and demineralizer bed to maintain the purity of the water at the required level. Control is provided to maintain the pH between the value of 6 and 7.

Water for the steel shield cooling system is charged into the system through a deaerator and demineralizer of the primary cooling circuit. The system is controlled to maintain the pH at a value between 9.5 and 10.5 and sodium sulphite is injected to remove dissolved oxygen. No demineralizer is provided on this system.

The aluminum shield cooling system is initially charged through the demineralizer of the primary cooling circuit, the deaerator being bypassed for this purpose. Control is provided to maintain the pH at a value between 6 and 7, and approximately 5 g.p.m. is fed through a mixed-bed demineralizer to ensure the removal of copper from the system.

Cooling water for the tanks of the wet storage area is initially charged through its own vacuum deaerator and demineralizer, and during operation this water is normally circulated at the rate of 100 g.p.m. through a filter, but provision is made to bypass approximately 20 g.p.m. through the vacuum deaerator and demineralizer in order to maintain the purity at the required level. No pH control will be included in this system. This equipment will be used to clean up contaminated water from both the storage block and the contaminated dump tank in the event of a rod rupturing.

On the heavy-water system, a demineralizer only is provided and no provision is made for pH control.

Emergency Cooling

Under normal conditions the pile is cooled by a re-circulating system as described above, but under emergency conditions cooling of the fuel rods will be by gravity flow in a one-pass system.

Failure of the main pumping system or a ruptured fuel rod will cause the pile to trip and also automatically bring the emergency cooling system into operation. For this purpose a storage reservoir of 850,000 gallons is provided on the side of a nearby hill. An additional storage of 150,000 gallons is maintained for fire protection.

An emergency dump tank of one million gallons capacity is located at an elevation below that of the lower header of the pile and remains empty during normal operation of the main cooling system.

This dump tank is provided with compartments so that if the emergency system is dealing with a ruptured rod the contaminated water will be isolated from the rest of the tank which must be kept clean to receive water from the pile during emergency cooling due to pump failure alone.

The main 850,000 gallon storage reservoir rides on the high-pressure side of the system through a check valve, normally kept closed by the 240 p.s.i. pump pressure. Should the pump pressure fall below approximately 50 p.s.i., the check valve will open and a second, automatically operated, valve above the emergency dump tank will also open, permitting water from the reservoir to flow by gravity through the pile and into the dump tank.

If a rod splits, the fission products monitoring system will trip the pile and shut down the main pumps. Tripping the pile and pumps in this way will result in a loss of pressure and the emergency cooling system will come into operation as described above. The contaminated water from the ruptured rod will flow into one of two 75,000 gallon compartments in the dump tank until the ruptured rod has been isolated.

During the few seconds required for the pumps to stop, a certain amount of contaminated water will flow in the twenty inch line from the pile to the delay tank but it will not reach the delay tank. When the emergency cooling system is operating the delay line is by-passed and the "slug" of contaminated water will flow directly into the contaminated compartment of the dump tank. The line will be flushed with clean water flowing through the pile from the storage reservoir.

Emergency cooling water discharges over a loop at a higher elevation than the top of the calandria to prevent accidental un-watering of the entire system.

When a ruptured rod has been isolated and the lines cleared of contaminated water, a sufficient number of pumps will be started to provide cooling for the pile to operate, under shut-down conditions, on the re-circulating system in order to conserve the supply of emergency cooling water.

The contaminated water in the smaller compartments of the dump tank will be pumped through the clean-up treating plant at the rate of 50 g.p.m. and thence to the 850,000 gallon clean water compartment of the tank from where it will be returned to the reservoir by the 300 g.p.m. pumps provided for that purpose.

The maximum flow obtainable from the emergency supply is 1400 g.p.m., so that ample cooling will be provided, since only 30 per cent of the normal flow is required one second after shut - down. As the heat load falls off still further, with increasing time of shut-down, the flow will be regulated and reduced still more to provide sufficient cooling water for four weeks operation under shut-down conditions.

As a pile trip will automatically cause part of the heavy-water to be dumped into its own tank, it is not necessary to provide emergency cooling for the heavy-water. Similarly, the steel and aluminum shields will generate almost no heat under shutdown conditions so that it is not necessary to provide emergency cooling for the water-cooled shields.

Sea-Water System

The sea-water carries an unusually heavy silt load, which increases considerably during the monsoon season when surface material is carried down from the surrounding hills by the heavy rains.

The sea bed slopes very gently downwards, away from the shore line, and is covered with a layer of mud approximately 15 ft. thick. The water off the site is so shallow that it is necessary to go out approximately 3500 feet from shore to secure sufficient depth of water for pumping.

As the sea area off shore from the site is a turning ground for oil tankers arriving at a nearby oil dock, the choice of site for the sea-water intake was somewhat restricted.

The pumping station consists of a caisson having three compartments; two compartments being screening chambers and the third containing the pump suctions. Water enters a screening compartment through a coarse screen and a gate in the wall of the caisson and flows through a second gate and a second finer screen into the pumping chamber. From there it is pumped into the main pipeline. When one screening chamber requires cleaning its gates will be closed and water will be passed through the other one into the pumping chamber.

For the pile cooling requirements four vertical centrifugal pumps are provided, each having a capacity of 2700 g.p.m. against a total head of 120 feet. Only three pumps are normally required, the fourth being standby. A fifth pump will be installed later to supply additional cooling water for loop experiments and this will be identical with the main pumps and will, of course, discharge into the same header and pipeline. The sea water pumps have nickel cast-iron bodies; Monel impellers.

To prevent fouling of the system, by silt settling out of the sea water during shut-down periods, by-pass lines are provided to permit the sea water lines to be flushed before the heat-exchangers are brought into operation.

Chlorination of the sea water is carried out at the intake as outlined above in the description of the cooling system.

The pipeline to the shore is a welded steel pipe, lined inside with concrete. The pipe is carried on a pier of reinforced concrete constructed on the rock of the sea bed.

For the disposal of return sea water, a pipe is carried from the reactor to the sea wall where the return flow discharges into an open channel.

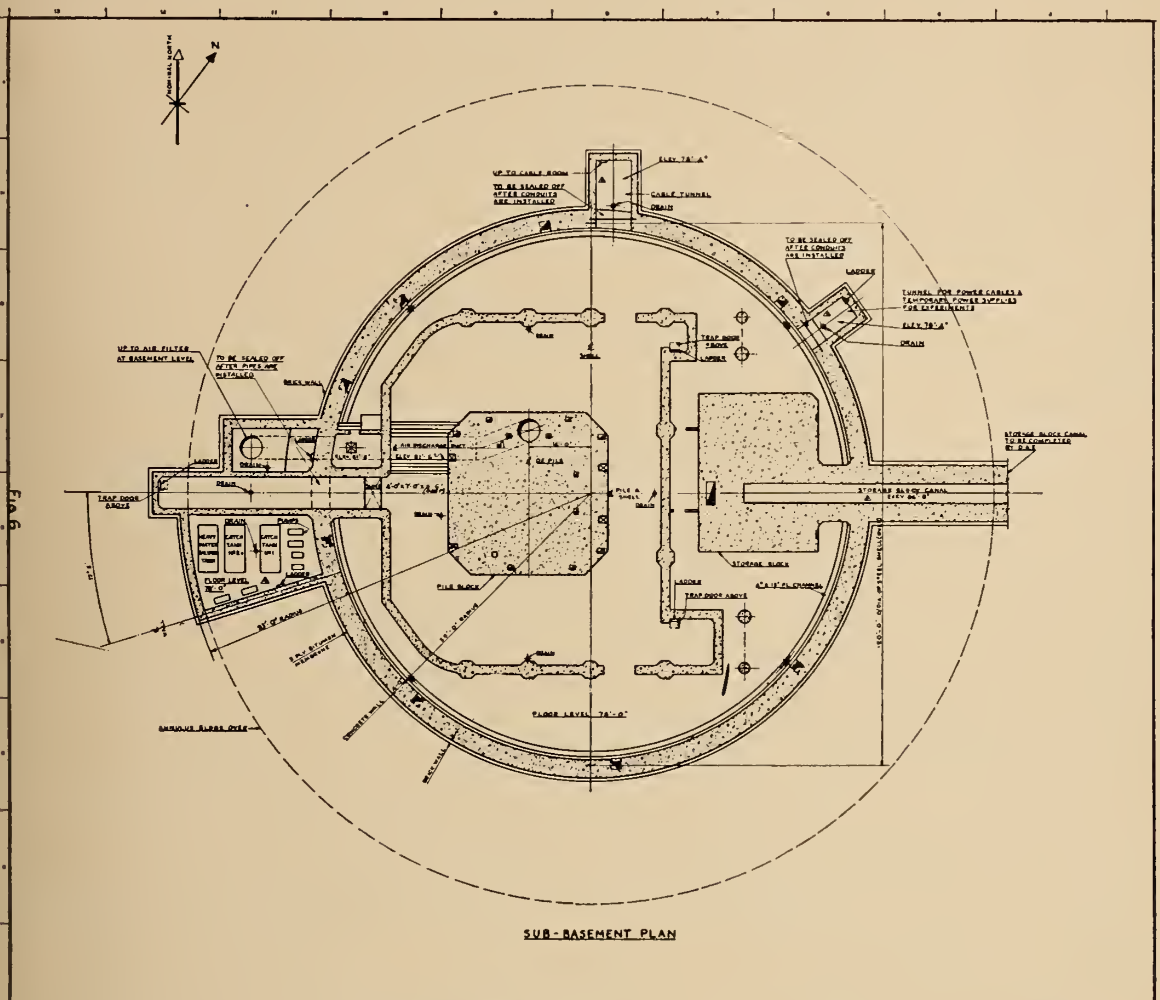


Fig. 6—Sub-basement plan of reactor hall and annulus.

Electric Power Supply

Power for the operation of the plant is supplied from the grid system feeding the Bombay area. Two single circuit, 22 kv. widely separated lines transmit the required power a distance of approximately two miles to the main substation of the Atomic Energy Establishment. From this station power is distributed at 11 kv. to the various load centres including those of the C.I.R. project.

The reactor load centre comprises the necessary switching and two transformers, each rated 2500 kva. and capable of carrying the full load requirements of the reactor. Power is supplied at 440 volts by underground cables to two separate sections of the distribution board. The load of the reactor building is divided equally on these two bus sections and provision is made for instantaneous transfer of either section to the sound feeder circuit in the event of failure of one of the two circuits. This arrangement reduces the short circuit duty on all switching equipment and also the hazard of complete shutdown.

Power for the sea water pumps is transmitted via overhead cable along the pipeline pier at 11 kv. and separate transformers are provided at the intake caisson to reduce the voltage to 440.

Push button stations for the control of the various motors are located at three principal stations in the plant:

(*a*) The pump control panel for the cooling system, located near the main switchboard in the annulus building.

(*b*) Control panel for all fans, pumps and compressors of the air-conditioning and exhaust system, located in the air-conditioning plant room in the annulus.

(*c*) Heavy-water pump controls located in the main control room.

Push-button starters for air-compressors, sump-pumps, motor-operated doors and other special equipment are mounted adjacent to the equipment as they are always started under the supervision of an operator.

A message system is provided to transmit written instructions from the main control room to the two motor control centres in the annulus building.

The sea-water pumps are controlled from the annulus pump room, but provision is also made for stopping and starting them at the intake caisson during maintenance work or in emergencies.

Standby power of 440 kw. is furnished by a diesel set consisting of two 220 kw. Diesel generators.

The Diesel plant will carry only the loads essential for operation when the pile is shut down. Failure of normal power will automatically trip the pile.

On failure of the regular power supply, the starters of the two Diesels will operate simultaneously and the machines should start within 15 seconds. In the event of one machine failing to start, however, protection is provided for the standby system; the standby power load is divided into two sections and all the more vital lighting and equipment are included in a 200 kw. preferred load. The first Diesel to start will pick up this preferred load so that should either machine fail to start, power will be available for the important equipment. Two identical machines are provided, to simplify the work of maintenance and for which simpler equipment for synchronizing is required.

Direct current for the instruments is supplied by motor generator sets with storage batteries 'riding on the line' to supply current in the event of a power failure.

Control Room

The main control room is located in the annulus building and contains all the instruments and control devices necessary for the proper and efficient operation of the reactor. On a large graphic panel are shown simplified flow diagrams for the heavy-water, helium, primary cooling and shield cooling systems, on which miniature instruments are mounted to show the relation of each to the process.

Adjacent to the control room is an instrument room containing the trip and alarm panels and other panels for which constant attention by the operator is not required, and an office and cloakroom for the convenience of shift operators.

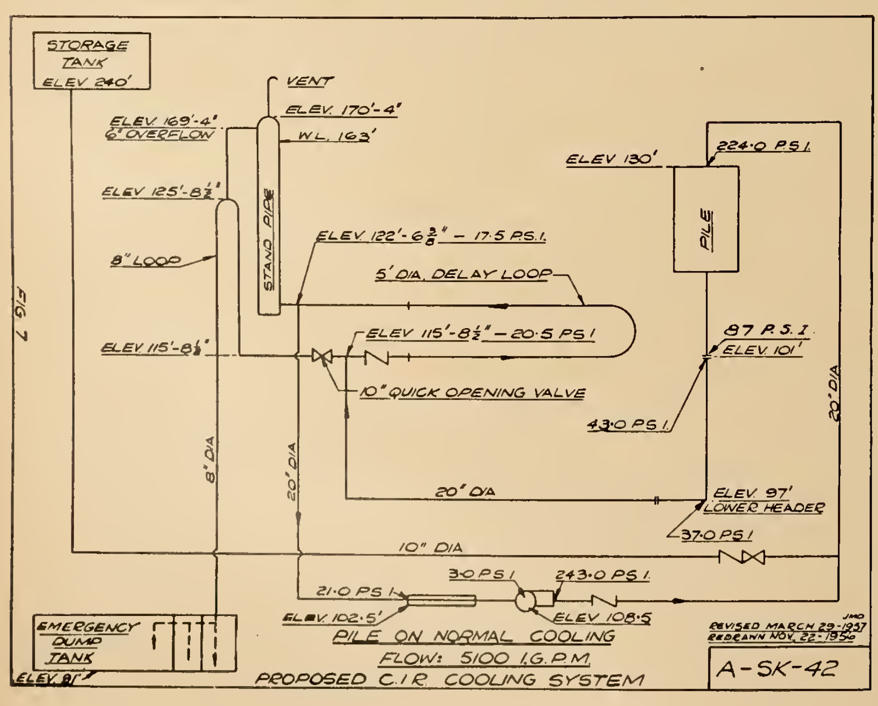
The control room is not accessible directly from the reactor hall as there is nothing to be gained by being able to look into the pile building from the control room and, in fact, windows or any means of access between the two rooms would constitute a definite weakness and would defeat the object of the pressure shell.

If an incident should occur which would justify the adoption of the pressure shell, one room above all others which must be entirely free from contamination is the control room. Similarly, if an incident should occur it will be of immense value to have as many instruments and as much control equipment as possible outside the contaminated area.

On C.I.R. therefore, as many instruments and controls as possible are placed outside the pressure shell. Where local controls are necessary they have been duplicated at appropriate points. Instruments which cannot be conveniently located in other areas, such as the pressure and temperature measuring instrument for the lower header assembly, are automatically scanned locally and the readings recorded in the control room.

The centralization of controls in a few locations as possible is made necessary by two factors which have influenced much of the design of this project. These are, first, the isolation of the reactor in a gas-tight pressure shell to guard against the effects of accidents and, second, the lack of suitably trained personnel and

Fig. 7—Flow diagram of normal primary cooling system.



the function of the project as a training ground for Indian scientists and technicians. With centralized controls for all the important equipment, a comparatively smaller number of highly trained men will be required to keep the equipment under control at all times.

Air-Conditioning Plant

The design of the air-conditioning and ventilating plant for the C.I.R. involved many factors not encountered in the design of other such plants. In addition to providing sufficient quantities of cooled and dehumidified air to meet comfort requirements in the building, the system is required to provide positive and extremely reliable ventilation to both the occupied areas and the pile itself.

Sufficient air must be drawn through the pile to remove the heat equivalent of about 200 kw. in the regions of the thermal shields and J-rod annulus. Air pressures within the pile itself must be held below those in the experimental areas surrounding it so that all air leakage will be inwards. All contaminated areas must be liberally ventilated to prevent dangerous build-up and escape of radioactive air.

All contaminated air must be efficiently filtered and discharged from the reactor building in a manner which will not create a health problem and will not increase the background radiation in other experimental areas of the Establishment.

Both fatigue of operating personnel and damage to experimental equipment must be prevented, in so far as they can be prevented by close control of temperature and humidity, irrespective of the outdoor climate.

All the above objectives must be accomplished with adequate and reliable safeguards and alarms against faulty or abnormal operation of the equipment.

For the reactor hall, pile and basement, the air-conditioning and ventilating system is equivalent to a one-pass or series system. Only one source of conditioned air is provided to the reactor hall. Once inside the building the conditioned air is made to flow in the direction of increasing exposure to contamination, until the main exhaust filters are reached. Just as much fresh conditioned outdoor air is supplied to the reactor hall as must be drawn through the pile and

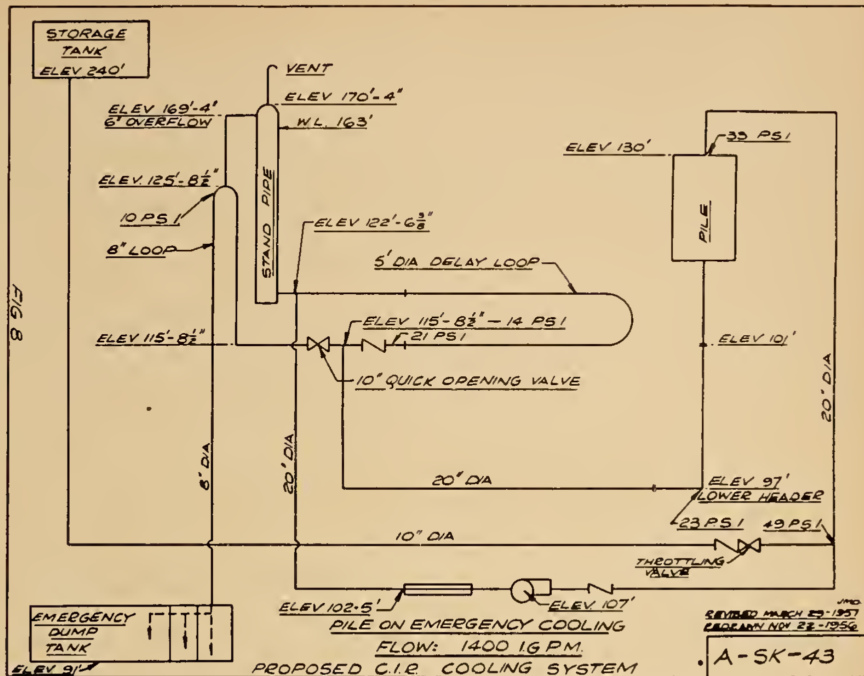


Fig. 8—Flow diagram of emergency cooling system.

exhausted from the contaminated areas. No re-circulated air is used in the reactor hall conditioning plant.

The reactor rotunda, basement and sub-basement areas are maintained continuously at a positive pressure of 0.5 in. w.g. with respect to the outside temperature; this provides improved control of the air motion and facilitates balancing the various ventilating systems within the building, especially those connected to contaminated areas and it also prevents the infiltration of untreated air.

Air is filtered and conditioned in the central conditioner, located in the annulus, at a rate of 24,000 cubic feet per minute. Of this, 22,000 c.f.m. are discharged through a duct and a (normally open) automatic pressure damper into the reactor hall and 2,000 c.f.m. are diverted to serve the fresh air requirements of certain rooms in the annulus building.

Approximately one-third of the air supplied to the reactor hall is drawn through secondary filters and into the pile through one of two intake ducts. A further one-third of the air is drawn through the basement shielded rooms and thence through filters and a booster fan into the second intake duct to the pile. The remaining one-third is made up of air used in ventilating the header rooms and storage block and of air finding its way by leakage into the pile structure.

The ventilation provided is as follows:

Reactor Hall	—22,000 c.f.m.
Shielded rooms	—Not less than 10 changes per hour
Lower header room	—22 changes per hour
Upper header room	—28 changes per hour
Storage block openings	—min., velocity of air 100 f.p.m.

Air (withdrawn from the pile header rooms and storage block), originally conditioned but now contaminated, is drawn through an exhaust duct and a second (normally open) automatic pressure damper to the filter compartment.

The filter compartment is located in the annulus diametrically opposite the conditioner location. It contains four parallel banks of absolute filters, with each filter element supported in a specially constructed pressure-type frame designed to eliminate air leakage past the filtering media.

Air leaving the filters is discharged to the stack through either one of two identically rated electric motor-driven blowers, each capable of handling the total exhaust air requirements. A mechanical shut-off damper is provided on the upstream side and a water-seal is provided on the discharge side of each blower to facilitate maintenance of the fans and motors.

In the annulus building the main concern is with air conditioning and ventilating for the comfort of the occupants. A few of the annulus rooms are regularly occupied and in the tropical Indian climate some measure of cooling is desirable. The control room has its own air-conditioning plant which, like the reactor hall conditioner, is capable of providing independent control of both dry bulb temperature and humidity. Unlike the reactor hall system, however, the control room conditioning system is designed to take full advantage of the economies associated with the utilization of re-circulated air.

In the remaining areas where cooling is required, that is, the exhaust fan motor room, electrical equipment room, switchboard room and air-conditioning equipment room, ceiling suspended unit coolers are used.

A central refrigerating plant has been provided to serve the total cooling and dehumidifying requirements of the reactor hall and conditioned annulus rooms. It consists of two, identically rated self-contained, water chilling machines, operating in parallel and delivering water at a temperature of 46 deg. F. to the conditioners and unit-type coolers strategically located throughout the conditioned areas. The rated capacity of each machine is 130 tons of refrigeration.

Conditions at the site are such that for the five year period 1951 to 1955 inclusive, the daily maximum temperature recorded at Santa Cruz Airport near Bombay reached a value above 80 deg. F. on 1,785 days; that is an average of 357 days each year. An analysis of the meteorological data has shown that it would be most unwise to have designed for a wet bulb temperature of less than 84 deg. F. with a simultaneous dry bulb of 92.5 deg. F.

The humidity in the area is such that under certain conditions it is necessary to heat the air before delivering it to the conditioned zone, for if air were to be delivered to the occupied zone at the temperature required to lower the humidity to the design figure of 50 per cent, the dry bulb temperature would be considerably below the figure of 75 deg. F. adopted as standard for the occupied zone. This would result in a serious health problem.

Amongst the most important areas serviced by the ventilating plant are the upper and lower header rooms and the storage block, and the ventilation of these three sources of contamination must be adequate under all conditions.

The upper and lower header rooms and the storage block are connected to a common exhaust system which joins with the main exhaust duct from the pile in a plenum chamber located above the main exhaust duct and adjacent to the sub-basement wall. Normally, the suction head for this exhaust system is provided by the two main exhaust fans in the annulus.

In the event of failure of the main power supply, the quantity of air handled by the main exhaust fans will be reduced by lowering the fan speeds to avoid excessive loading on the standby power plant. Reduction of the main fan speed, however, inevitably leads to a reduction in the suction head on the upper and lower header rooms and storage block ventilating ducts with a consequent reduction in the ventilation of these areas. A small booster fan is therefore, located in the sub-basement plenum and under normal operating conditions it is by-passed, but on interruption of the main power supply, it will start up and run on standby power. By this means the storage block and the upper and lower headers are adequately and continuously ventilated irrespective of the condition of the main power supply.

All the annulus areas which are not air - conditioned are positively ventilated with filtered outdoor air. Contaminated exhaust air from such areas as the heavy-water storage and salvage rooms, ion exchange and deaerator rooms, etc., is drawn through the absolute filters already described and discharged to the stack by the main exhaust blowers.

Acknowledgments

The author wishes to thank Atomic Energy of Canada for permission to publish information relating to the design of NRX and C.I.R. and acknowledges the assistance of Mr. F. W. Orlando, Mr. G. A. Alexander, Mr. D. G. Brooking and other members of the staff of the Shawinigan Engineering Company Limited.

Fig. 9—Control room.

Canada's NRU Reactor

F. W. Gilbert

Manager, Operations, Atomic Energy of Canada Limited

AS EARLY as 1949 it became apparent that the NRX reactor at Chalk River could not fulfil all the requirements for experimental atomic energy work in Canada. Although the neutron flux was one of the highest in the world, still higher fluxes were needed for many experiments. These experiments were both for basic research in nuclear physics and for engineering development studies for power producing reactors. As a result it was decided to proceed with conceptual designs of a reactor having approximately five times the NRX neutron flux.

In 1957, as a result of the effort and ingenuity of many people and organizations, the NRU will begin operation. Its design and construction has involved every phase and type of engineering. The total cost of the reactor without heavy water is about $52,000,000. With 70 tons of heavy water at $56,000 per ton, the cost is nearly $56,000,000.

The reactor as built has a nominal heat output of 200 Mw*. It is hoped that this figure will be exceeded. It is moderated and cooled with heavy water (99.75% D_2O). The fuel is natural uranium. The maximum flux is 2.5×10^{14} neutrons/cm^2/sec.

The choice of fuels and moderators is somewhat controversial. Canadian experience has shown that the combination of natural uranium with heavy water as a moderator, results in a reactor small enough to give high flux at a given power, but large enough to permit the insertion of experiments of appreciable size. As it is a natural uranium reactor, NRU is a good plutonium producer. Some revenue will be realized in the first few years of operation by the sale of irradiated uranium containing plutonium, to the U.S. Atomic Energy Commission.

The building of a reactor of this size involves a number of problems. To appreciate some of these problems, certain parameters more or less unique to nuclear reactors should be described:

This paper describes the design and operation of the new research reactor of Atomic Energy of Canada Limited, at Chalk River, Ont. Known as the NRU reactor, this will probably be the most powerful neutron-flux producer of its type in the world when in full operation during 1957.

(*a*) There is a very concentrated heat output. In a vessel less than 12 ft. in diameter and 12 ft. high are generated 200 Mw. of heat, i.e. 6.8×10^8 B.t.u. per hour. Each fuel element contains only 120 pounds of uranium. Some generate 1.5 Mw. of heat each. The cooling system and heat-transfer rates have to be adequate to cope with this problem. The upper limit of power output is the heat that can be removed, not the heat that can be generated. In a nuclear reactor there is no practical limit to the latter.

(*b*) Everyone is now aware that personnel must be protected from the intense radiations generated in a nuclear reactor. Not so many realize that this same radio-activity, particularly in the form of gamma and neutron radiation, generates heat on being absorbed in reactor materials. In the NRU reactor approximately 1 Mw. of heat is formed in the structure by radiation. Any piece of metal, for example, that is in an intense radiation field must be cooled. In the NRX, air cooling is adequate for most components, but in the NRU water cooling is required.

(*c*) Practically any material in a neutron field becomes radio-active—the higher the flux†, the greater the activity. Maintenance under radioactive conditions is very costly. Hence it is economical to establish very high standards of construction to avoid future maintenance expense.

(*d*) All materials absorb neutrons but they do so to varying degrees. The spread in relative absorption is as much as a factor of 10^9. Neutron economy is directly related to the cost of construction and operation of a reactor. Any steps taken to reduce the absorption of neutrons will generally reduce costs. Hence considerable care is taken in the selection of materials of construction. It is to improve the neutron economy that heavy water is used as a coolant in NRU, but light water in NRX.

With these parameters in mind the resulting design of NRU can be more clearly understood. Figure 1 shows diagramatically the NRU reactor. The various components are:

1. The reactor vessel and reflector. 2. The upper header. 3. The lower header. 4. Upper shielding sections. 5. Side thermal shields. 6. Biological shield. 7. Thermal column. 8. Heat exchangers. 9. Circulating pumps. 10. Research facilities.

Not shown in this sketch are the following main components:

11. Auxiliary cooling circuits. 12. Heavy water purification system. 13.

*The unit megawatt (Mw.) is equivalent to one million watts. It is used here to measure heat output.

† No. of neutrons/sq cm./sec.

Helium purification system. 14. Reactor ventilation. 15. Control system. 16. Services. 17. Fuel handling and storage equipment. 18. Fuel rod design. 19. The building.

It is proposed to discuss each of these components or groups of components separately, relating them to the whole reactor.

Reactor Vessel and Reflector

The reactor vessel is a cylinder 11 ft. 6 in. in diameter and 11 ft. 9¾ in. high, inside dimensions. It is made up of three separate components, the shell, an upper and a lower header. These headers are bolted to the shell and closed with metal-to-metal seals. The reactor vessel is normally filled with heavy water, which flows in by way of the lower header and out of the top header to heat exchangers. Its purpose is to moderate the neutrons and also to remove the heat generated by fission. In the heavy water are suspended the fuel rods, the control-shut-off rods, and the experimental rods.

Aluminum is chosen for the reactor vessel as it absorbs relatively few neutrons, thus improving the reactor performance and also providing the maximum number of neutrons at the experimental holes. If stainless steel had been used there would have been a considerable attenuation of the neutron flux in passing through the vessel walls.

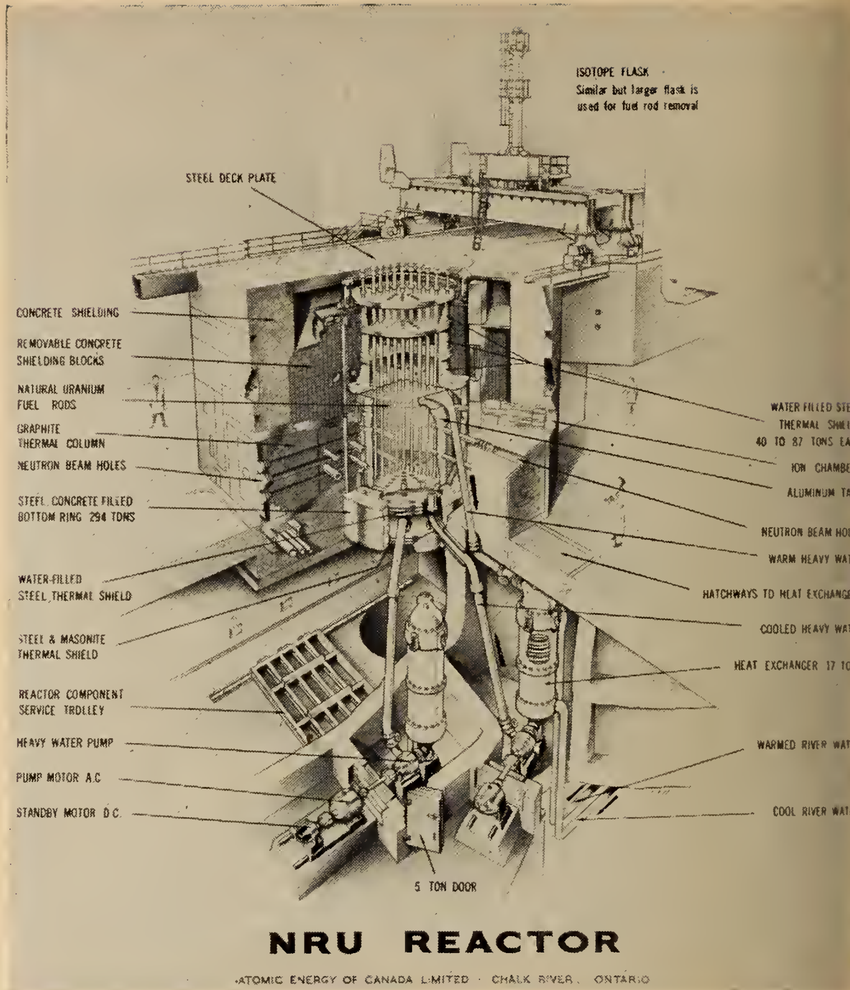
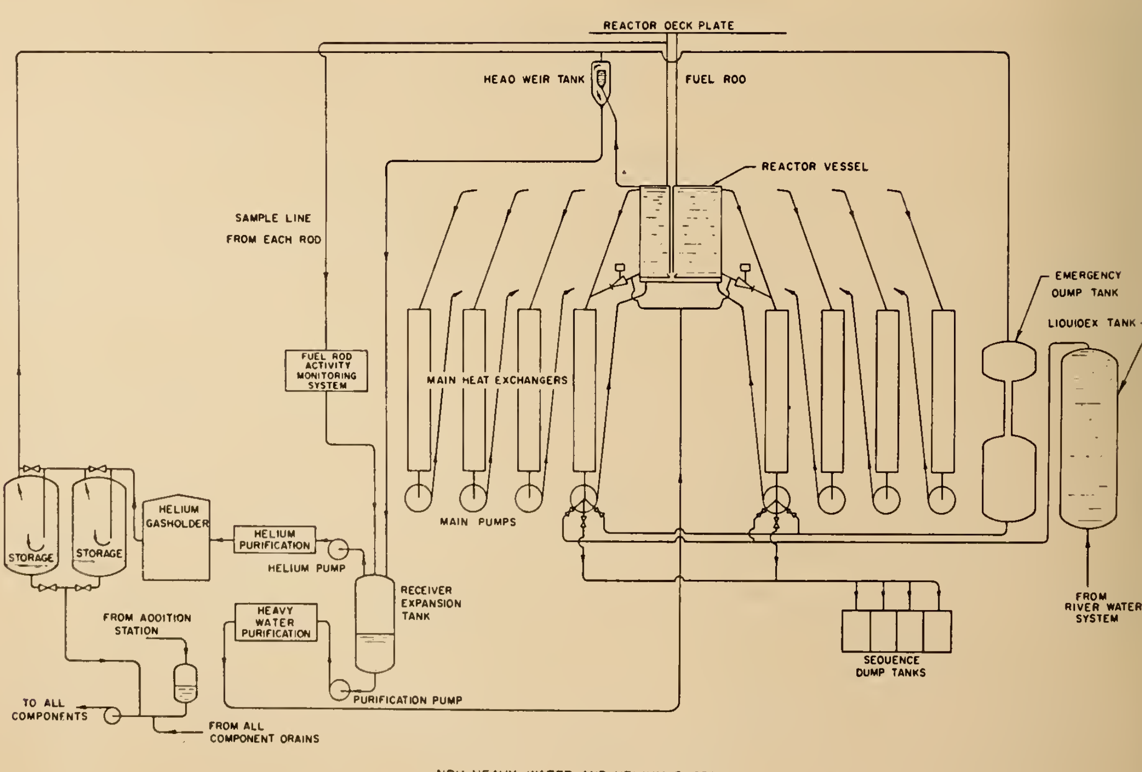


Fig. 1 (above) and Figure 2.



Outside the reactor wall there is a 6 in. annulus filled with CO_2 and then a neutron reflector. The reflector is an annular tank, 12 in. thick and 11 ft. 6 in. high made of aluminum and filled with ordinary water. The water is circulated through one of the auxiliary cooling systems. (Fig. 3.)

The Upper Header

The upper header is made of two tube sheets of stainless steel. Into it are rolled 227 tubes that extend to the top deck of the reactor. The tubes are seal-welded to the lower tube sheet, are supported above by springs, and are rolled into both sheets of the header. A system is provided to detect leaks into the intervening space.

To prevent distortion and failure of the top header by heat generated by the intense radiation, heat baffles are provided, consisting of blocks of steel fastened to the lower side in a mosaic pattern. They are cooled with heavy water from the vessel.

The upper header is connected by eight volutes to the heat exchangers.

The Lower Header

The lower header is connected to each of the eight circulating pumps and distributes heavy water to the fuel rods. Inserted into the upper face are bushings into which the lower end of the fuel assemblies are inserted. Most of the heavy water flows up through these assemblies, and leakage ports in the inserts provide a small flow into the moderator. A heat baffle is also provided for the lower header.

The normal flow of heavy water is into the lower header, through the reactor, and out through the volutes in the upper header. The flow-diagram is shown in Fig. 2.

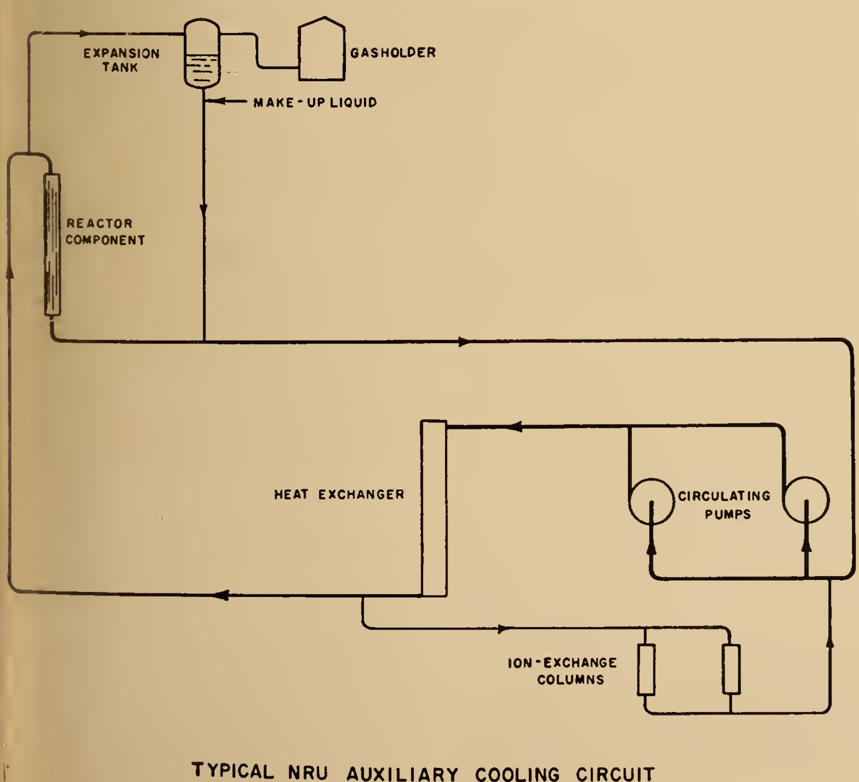
The Upper Shielding Sections

Three carbon steel shields, known as "boiler sections", supply the main shielding for the top of the reactor. The fabrication consists of two tube sheets into which are welded 406 vertical tubes, the whole being surrounded by a steel shell. Water is circulated through each section. The boiler sections provides 23 in. of steel plus 9 ft. 7½ in. of water shielding.

The lowest boiler section is also one of the main structural members. It is supported by three columns which are bolted to the base ring. With the base ring it supports the other boiler sections as well as the deck plate, the top header, the fuel rods, and all equipment associated with them.

As an added complication, the reactor was designed for a possible change-over to a pressurized vessel. If this is done there will be an upward thrust of 500 tons on the lowest boiler section.

Figure 3.



Side Thermal Shields

Outside the reflector of the reactor vessel there is a steel thermal shield, fabricated in sections of cast steel 12 in. thick. The sections slightly resemble barrel staves. Each is cooled by a flow of water across the inner face. The sections are fitted step-wise together, close enough to prevent radiation leakage but loose enough to provide for thermal expansion.

The Biological Shield

This surrounds the thermal shields. It is 9 ft. 6 in. thick and is made of high density concrete. Ilmenite ore and magnetite sand are used as aggregate. The resulting concrete has a weight of about 220 lb. per cubic foot.

Thermal Column

A major research facility provided is the thermal column. The purpose of a thermal column is to provide a large volume in which thermal or slow neutrons are present but very few high energy neutrons and little gamma radiation. To accomplish this the column is filled with closely-packed, high-density graphite blocks, forming a column which is approximately 8 ft. square at the inner end, expanding to 10 ft. 5 in. square as a maximum. It is 12 ft. long. The inner end is separated from the reactor by two thin walls of aluminum and a number of bismuth rods. These bismuth rods provide some shielding to reduce the gamma flux in the column. The column is surrounded by a series of castings which range from 12 in. to 15 in. thick. The castings are covered on the inside with a cadmium plating 0.040 to 0.060 in., plus ¼ in. boral plates. Boral plates are made of a mixture of boron carbide in an aluminum matrix, and the whole clad with 0.20 in. of aluminum on both faces.

The purpose of the boron and cadmium is to reduce the gamma radiation which would come from the steel surfaces if they were irradiated with neutrons. The bismuth rods and the steel castings around the thermal columns are water cooled. The graphite itself is air cooled.

Near the inner face of the column is a shutter made of lead about 2½ in. thick, with a surface of boral. On the outer end of the column is a lead shield, approximately 18 in.

thick, which has a boral inner liner.

Heat Exchangers

The design of the heat exchangers is a little unusual due to the high cost of heavy water. Some of the design parameters are:

(*a*) Heat to be removed: 200 Mw.
(*b*) Heavy water flow: 22,000 i.g.p.m.
(*c*) Pressure drop: 9 p.s.i.
(*d*) Temperature drop 48 deg. F.
(*e*) Heat transfer rate: 350 B.t.u./hr./ft.^{2}/F°.

The heavy water flow is inside from normal cooling systems for four reasons:

(*a*) When the reactor is once started, cooling must be provided unless the full charge of fuel elements is removed. The heat generated after the reactor is shut down one hour amounts to about 1% of full power.

(*b*) In the winter the cooling water from the river is near 33° F., so that there is danger of freezing the heavy water, which has a freezing point of 38.8° F.

(*c*) Heavy water is expensive ($28.00/lb.)

(*d*) During operation the heavy

(3) Four pumps are equipped with motors that can be run at half speed to permit reduced flow if desired.

(4) The above four pumps are also equipped with d.c. motors connected through over-riding clutches. In case of complete hydro power failure these motors will provide sufficient circulation for cooling with the reactor shut down.

The pumps themselves are centrifugal. Each is capable of delivering 2800 i.g.p.m. of heavy water against a head of 188 ft. Double mechanical shaft seals are used.

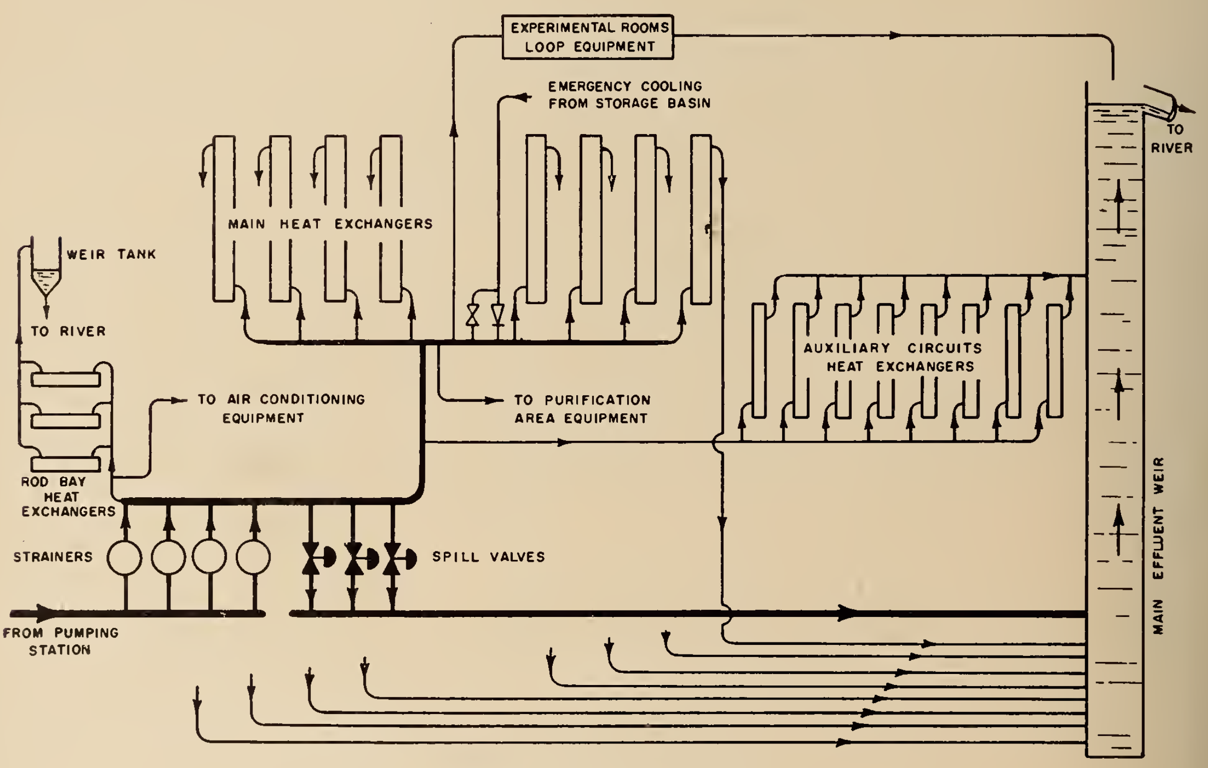


Fig. 4. NRU river water system.

the tubes with light water in the shell.

Number of coolers 8
Number of tubes per cooler 2869
Diameter of tubes ⅜ in. O.D.
Effective length 186 in.
Material Type 304 Stainless steel

Each end has a double tube sheet with a means of detecting leakage into the space between.

Heavy Water Circulating Pumps

There are eight heavy water circulating pumps. When any are operating, heavy water is circulated into the bottom of the reactor vessel, out of the top and through the heat exchangers. The maximum rate is about 22,000 g.p.m. (see Fig. 2).

The reactor cooling system departs

water emits gamma radiation due to the decay of N_{16} formed by neutron irradiation of O_{16}. At the same time some deuterium atoms give off neutrons under gamma radiation. As a result heavy shielding is required around the pumps and heat exchangers in the reactor system.

A number of precautions are taken to ensure that heavy water circulation is not interrupted.

(1) Power is brought into the plant from two sources — des Joachims and Bryson power stations.

(2) Half the pumps are powered from each station with switching gear so that if either source fails the whole load is taken by the other in three seconds. Flywheels maintain the motor speed during this period.

The following motors are used:

(i) Four two-speed motors: 250 62.5 h.p.; 1800/900 r.p.m.; 2300v 3-phase; 60 cycle.

(ii) Four single-speed motors: 25 h.p.; 1800 r.p.m.; 2300v; 3-phase 60 cycle.

(iii) Four auxiliary motors: 20 h.p 690 r.p.m.; 115v; d.c.

Research Facilities

The reactor and the thermal co umn are equipped with approximate ly 24 beam ports. These are tub or holes through the biological shiek to allow the passage of beams neutrons as required. (When not use the holes are plugged.) Also is possible to place materials or equi ment in these holes for irradiatio

A flux as high as 1.6×10^{14} neutrons/cm^2/sec. is available.

Materials can also be irradiated in the "J-rod" annulus. This is the space between the reactor wall and the water reflector. Materials to be irradiated in this space are inserted in rod form.

Provision is made for four pneumatically-operated tray rods — two in the J-rod annulus and two inside the reactor vessel. These tray rods are for the irradiation of small samples. There are forty positions in each.

Three rod positions are designed to allow tubes to run completely through the reactor. These tubes can then be connected to their own external cooling systems independent of the normal heavy water circulating system. Such a system is known as a "loop" and is used for testing fuel material and sheathing under temperatures, pressures, and neutron fluxes expected in power reactors.

Auxiliary Cooling Circuits

Nine auxiliary cooling circuits provide cooling for reactor components. Each of these circuits (see Fig. 3) is a closed loop so that close control may be maintained both on radioactivity and corrosion. The equipment is generally constructed of mild steel except in a few instances where heavy water cooling may be used or the piping is inaccessible. Stainless steel is used in these instances.

The systems cooled are: 1. Reflector. 2. Heavy water J-rod. 3. Grouped J-rods. 4. Bismuth rods. 5. Thermal shields. 6. Experimental hole gates. 7. Experimental hole plugs. 8. Interspace concrete. 9. Fuel rod monitors.

Each of these circuits requires high reliability. In the case of the rods, reliability must be equal to that of the main cooling system.

Heavy Purification System

It is necessary to maintain high purity in the heavy water used for moderator and coolant. A conductivity of 5 x 10-7 mho is the objective. At this purity the net rate of decomposition under irradiation to D_2 and O_2 is very low. Activation of impurities is low and corrosion is predictable.

To maintain high purity water only aluminum-stainless steel systems are used, and part of the heavy water is circulated through a degassing system, a filter, and a mixed bedion exchange resin.

Monitors are installed in the heavy water system to detect failures of fuel sheaths. A small stream from each rod cooling channel is analysed for both fission product gases and "delayed" neutrons. The presence of either indicates a failure in a rod sheath.

Helium Purification System

A gas is necessary to fill the voids in the system. Argon becomes very radio-active under irradiation and would increase the shielding requirements; nitrogen combines to form nitric acid; CO_2, SO_2, etc., form acids with the heavy water to cause corrosion or to load the resins. Helium is found to be the perfect gas for the purpose as it is completely inert.

Helium of high purity is desirable so as to reduce the radiation from activated argon or other radioactive gases, to help maintain the heavy water purity, and to reduce corrosion in the vapour phase of the system.

Impurities in the helium are removed by sorption on coconut charcoal at liquid nitrogen temperatures. Any heavy hydrogen in the system due to the decomposition of D_2O is recombined with oxygen using a catalyst. It is removed prior to the purification.

Reactor Ventilation

Air that is subject to neutron

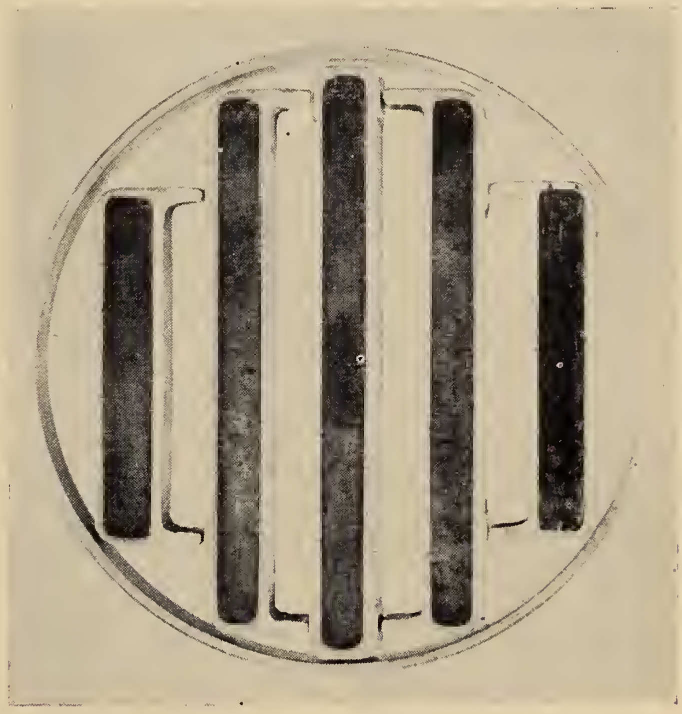


Fig. 5 (above) and Fig. 6.

bombardment becomes radio-active, chiefly due to the formation of argon 41 with a half life of 1.8 hours. Airborne dust can also become active, depending on the material. For this reason it is essential that there be no flow of air or gas from neutron fields out into operating areas. To prevent such a flow the interior of the biological shield is kept at a pressure slightly below atmospheric. This system is coupled with the air cooling that is provided in the thermal column.

About 10,000 c.f.m. of air is pumped from the combined system. This air is passed through "absolute" filters to remove dust and then is blown out of a stack which is on a hill half a mile from the reactor building. The top of the stack is 383 ft. above the main floor of the reactor building. Except under very severe atmospheric inversion conditions this provides sufficient dispersion so as not to interfere with sensitive experiments in any of the laboratories.

Further ventilation is provided in the building for removing any radioactivity which might be released from the surface of fuel rods after removal, from pump glands, from other leakage, or during maintenance work. The same disposal principle applies. Dust is removed on filters, gases are dispersed.

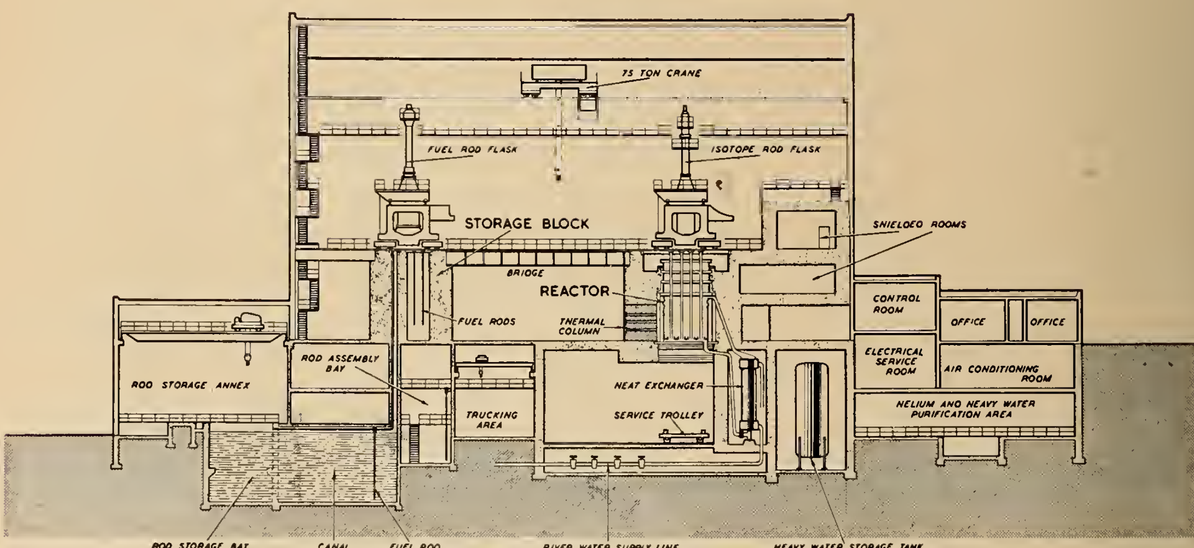


Fig. 7. East-West cross-section of NRU building.

Control System and Safety System

A reactor control system is of necessity complex. Four requirements must be met:

(*a*) It must be fast enough.

(*b*) It must be reliable.

(*c*) It must have a minimum of false signals.

(*d*) Each component in the reactor system must be checked according to its contribution to the hazard.

The main control of the NRU reactor is by the use of 16 neutron-absorbing rods. These rods serve the double purpose of control and shut-off. Under normal control, the rods are automatically operated to bring the reactor to a pre-set power and to maintain this power. Any failure in the system will cause all rods to drop in, hence shutting the reactor down. The reactor cannot be started until all hazardous conditions are removed. Such hazards as:

1. overpower;
2. too rapid an increase in power;
3. high temperature in the heavy water;
4. failure of cooling systems;
5. failure of electric power;
6. failure of fuel sheathing;

will cause the reactor to shut down. To provide reliability all instruments are "fail safe"; i.e., an instrument failure will be interpreted as a hazardous condition. This provides for safety of operation but does result in a number of false shutdowns.

To overcome false shutdowns many circuits have three instruments so coupled that it requires the identical signal from two to shut the reactor down. The arrangement not only reduces the incidence of false trips but also permits instruments to be inspected and removed for servicing while the reactor operates.

It should be noted that failure of any component in the reactor system could result in major damage; therefore it is necessary to have continuous instrumental inspection on over 250 systems. These include the overall reactor, each fuel element, all auxiliary circuits and most experimental units.

The large number of instruments requires a close balance between safety, costs, and continuity of operation. To provide the service considered necessary, there are 4,000 process instruments and 1,200 electronic devices.

Heavy water is not normally used to control the reactor, but if necessary the reaction can be stopped by dumping the heavy water from the reactor vessel and cooling can be maintained. (See Fig. 2.)

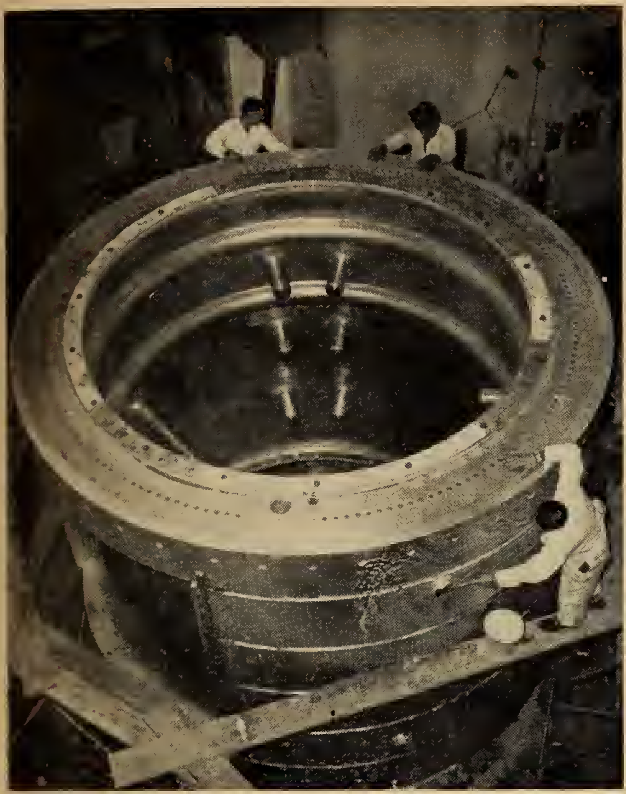
Services

Very elaborate services are required for an operation such as the NRU. The main systems are water, steam, air, vacuum, gas, electrical and mechanical.

Water — The main water supply is the process (or river) water which cools the heat exchangers in the reactor system. (Fig. 4). No treatment is given except to pass it through a 1/16 in. mesh strainer and to dose it periodically with chlorine for algae control. The flow rate is about 22,000 i.g.p.m.

In addition, service water is supplied for general use other than reactor cooling. It is chlorinated and contains corrosion inhibitors.

Clarified water is supplied to the



fuel rod storage bays. It may be treated for corrosion and algae control.

Chilled service water is circulated to various air conditioning systems. The air conditioning units are required in some areas to improve electronic instrument reliability.

Distilled water is supplied for the rod handling equipment other than the main storage basins. It is also used for make-up in the auxiliary services.

Steam — is supplied for heating the building, for hot water, and as one of the services in laboratories. It can be used to drive a fan in the reactor ventilating system and a process water supply pump.

Compressed air — is supplied and distributed throughout the building at various pressures for instruments, laboratory service, cooling of reactor samples and to supply air masks when required. Both normal and oil-free air are available.

A service vacuum — is distributed to experimental and maintenance areas. The main receiver is held at 26 in. of mercury below atmospheric.

Propane gas — is also distributed to experimental and maintenance areas.

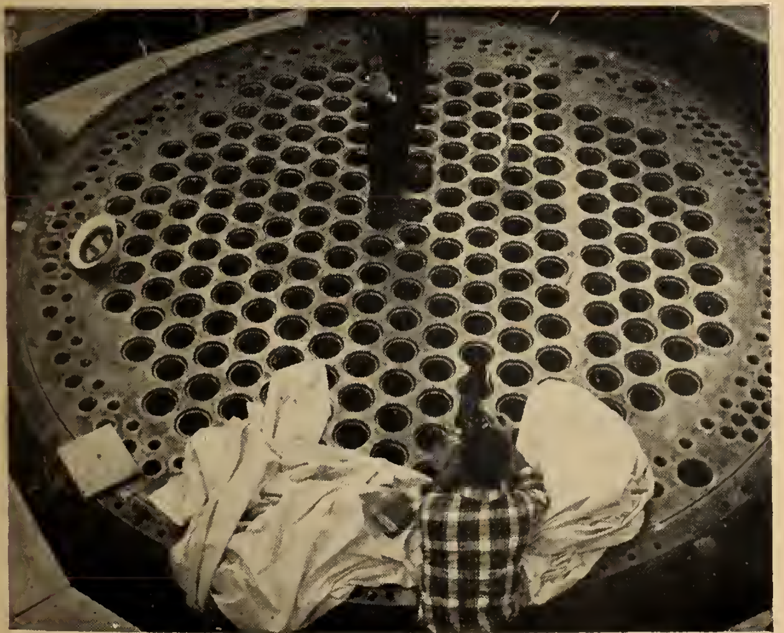
Power — is supplied to the plant at 120 kv. from two feeder lines — one each from Bryson and des Joachims. Part of the load is taken from each feeder. In case of failure of one, the whole load is placed on the other within three seconds.

In addition to the variety of voltages, there are four main power systems:

Class I — 125v. d.c. supplied by rectifiers and having two batteries riding on the line. Each battery consists of 60 two-volt cells.

Class II — 600v. a.c. supplied by d.c. motor generators. The d.c. motors use Class I power.

Class III — 600v. a.c. coming from the Hydro supply but backed



Top left: View of reactor vessel side walls complete with reflector tank. Expansion corrugations, re-entrant cans, and part of one through-tube can be seen. *Top right*: Installing permanent tubes. These are rolled into the top tube sheet and seal welded. These tubes extend through the boiler sections and are supported by springs in a plate resting on the uppermost boiler section. *Left*: View of the middle boiler section. The split in the lattice is where the experimental through-tubes pass between the rods.

up with diesel-generated power. The diesels start automatically if the Hydro power fails completely. The rectifiers for the Class I and II power are supplied by the Class III system.

Class IV power supplies a.c. power to the remainder of the system. The majority of the load is carried by the Class IV system.

The total power demand for the reactor can be 5,550 kva. An added 2,000 kva. may be required to operate experimental loops.

Cranes — Because maintenance involves the movement of heavy shielding and equipment there are 15 cranes in the building. The largest of these are a 75-ton crane in the main room and one 50-ton in the fuel rod annex. There are also seven monorails with numerous hoists.

Communications — In addition to the normal telephones, a private automatic exchange is installed. A public address system permits persons to be called and instructed in all parts of the building. Normally instructions for operational changes are given in writing. A pneumatic carrier system is installed to take messages from the control room to key points in the building.

Fuel Handling and Storage

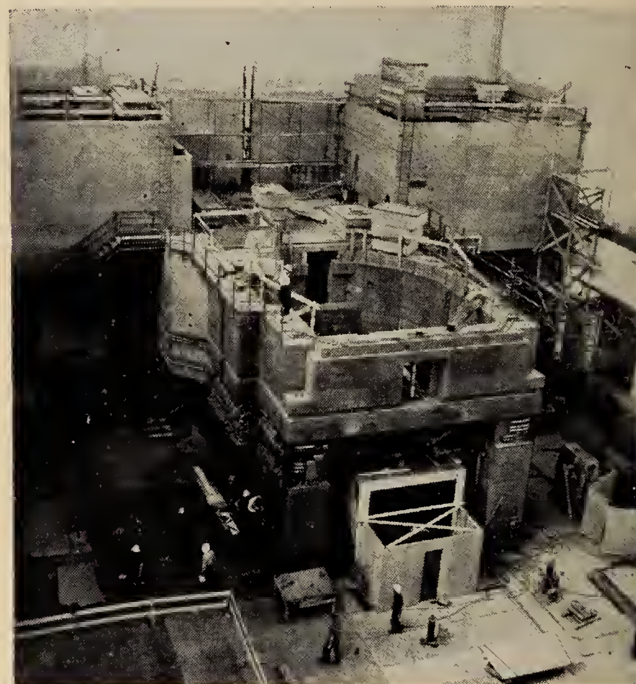
Uranium fuel clad in aluminum and in an outer tube (see Fig. 5) will be delivered to the assembly room in the NRU buildings. Here it will be assembled with the complete top section and flow tested. When installed, the top section fills the tube from the deck plate to the top header. When needed the rods are taken to the top of the storage block in the main reactor hall and inserted in drying tubes, in which the last traces of water are removed. A rod may then be picked up by the main flask, taken to the reactor and exchanged for an irradiated rod in the reactor.

The irradiated rod is transferred by way of the storage block to the storage bay. The top end, including the orifice section, is cut off and stored until most of the activity has decayed. The bottom or fuel end is held in storage for about 6 months before shipment.

After the radio-activity of the top section has decayed sufficiently it is taken apart. The components are decontaminated and inspected for reuse. If suitable they are sent to the rod assembly area.

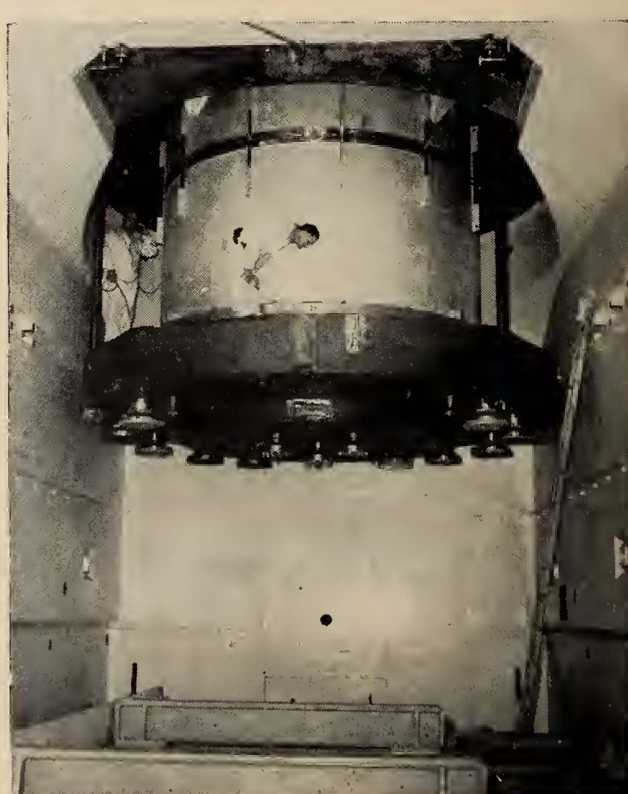
In addition to the uranium fuel rods, provision is made for other rods that go into the reactor or the annulus between the reactor vessel and the reflector. These are the control-shut-off rods, thorium rods, bismuth rods, and other special irradiations. Equipment is provided to assemble, test, install, remove, and store all these.

The transfer flask for irradiated fuel rods has a complex task. It must have the mechanical devices for mak ing the removal remotely and mus provide adequate cooling at all times the transfer from heavy to light wate must be done with a minimum loss o heavy water; and the whole operatio must be shielded to prevent hazard from both gamma and neutron irrad



Above: **Reactor hall during early stages of construction.**

Below: **Lifting a test reactor vessel into place. Bottom header and upper bottom shield are included.**



ation. The resulting flask weighs 240 tons. A second flask weighing nearly as much handles other type rods. Both of these are mounted on the rails above the reactor. (Only one shows in Fig. 1.)

Provision is made in the storage block for storing a complete charge of reactor rods in cooled, distilled water. Rods stored in this position may be returned to the reactor.

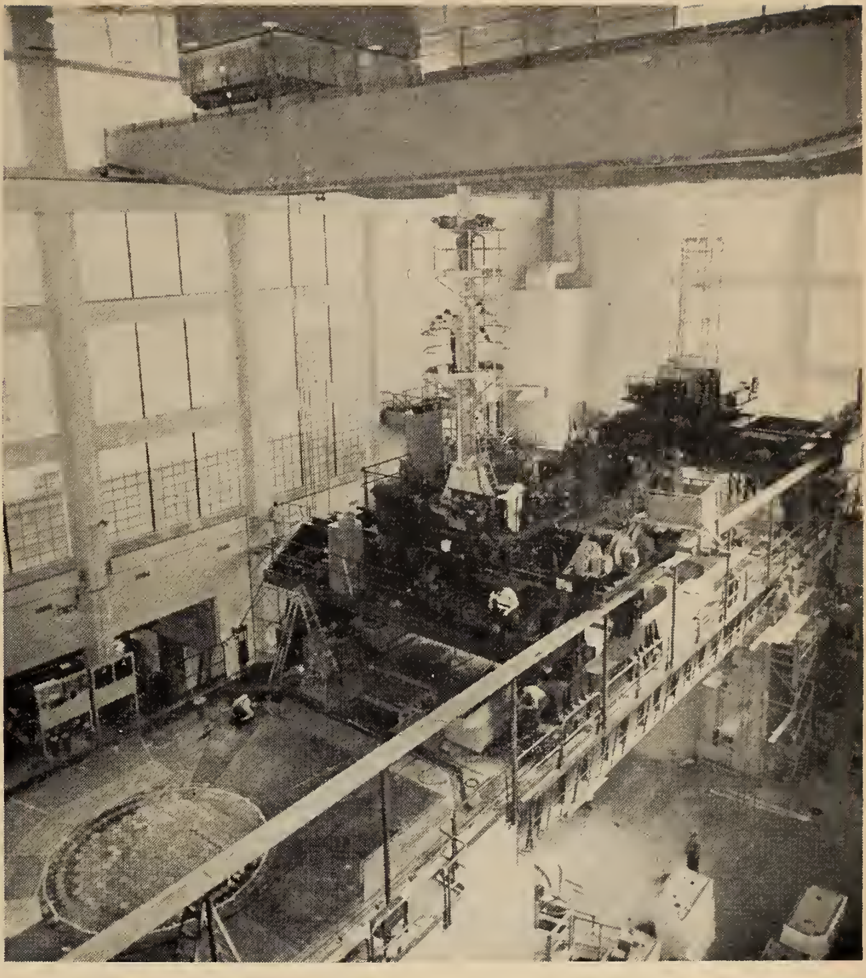
Fuel Rod Design

The heat output of an NRU fuel rod can be as high as 1.52 megawatts or an average of 152 kv. per linear foot. The vertical flux, however, is distributed according to a sine function. Therefore, the peak heat output is 238 kv. per linear foot. To provide sufficient surface for cooling, the rod is constructed of five flat plates. The plates are clad in aluminum and enclosed in a tube. A cross section is shown in Fig. 5. At a reactor power of 200 Mw., the maximum heat transfer rate is about 500,000 B.t.u./ft.²/hr.

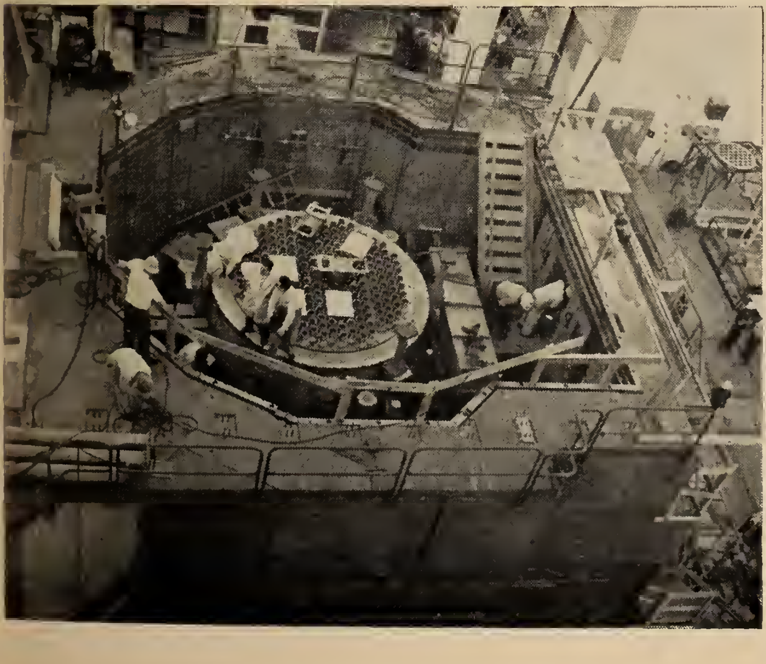
The Building

The building is constructed of brick walls on a steel framework. (Fig. 6). The main hall, which is 175 ft. long, 100 ft. wide, and 87½ ft. high, houses the upper part of the reactor and the storage block. (See Fig. 7.) Two side wings provide space for physics laboratories; one end wing houses the control room, change rooms, and offices; the other end wing houses the rod storage.

There are three basement levels containing service equipment, heat exchangers, building ventilation equipment, heavy water and helium purification equipment, as well as service and research laboratories. The total volume of the building is 4,100,000 cu. ft.



***Above*: An interior view of the NRU installation taken in April, 1957.**



***Below*: A view into the top of the reactor showing boiler sections and tubes leading to the upper tube sheet.**

Interior surfaces are generally painted to permit easy decontamination if such should be necessary.

The first reactor to operate in Canada, the ZEEP, became critical in 1945; the second, the NRX, in 1947. Both of these reactors have operated at capacity since. It is expected that they will continue to do so. NRU will supplement and extend the range of nuclear studies both theoretically and practically.

Original design studies were done by members of the staff of Atomic Energy of Canada Ltd. (at that time a division of the National Research Council of Canada).

Engineering has been done by the C. D. Howe Co.; Foundation Company of Canada are the prime contractors. Comstock of Canada subcontracted the electrical and instrument work. Hundreds of other firms contributed.

The Latest Prospects for Economic Nuclear Power

W. K. Davis and L. H. Roddis

Director, and Deputy Director, Division of Reactor Development, U.S. Atomic Energy Commission

Presented at the 5th Atomic Energy in Industry Conference of the National Industrial Conference Board, Philadelphia, March, 1957

WE HAVE been asked to look into the future of nuclear electric power in the United States. We are in a position much like that of the weatherman preparing a forecast for your daily paper. He looks at various signs and portents. He has trained himself to understand them as best he can. Some of the portents point one way; some point another but his audience isn't interested in his reasoning. They want his single best judgment, as you presumably want ours.

We trust this parallel with weather forecasting won't apply too literally. We are reminded of a test conducted by a friend who made trial weather forecasts for the Boston area for a year by use of random numbers. He then calculated the correlation with the actual weather, both of his forecasts and those made by the local weatherman, and — you guessed it — the random numbers achieved slightly better results. We refer to this experience merely to let you know how keenly aware we are of the perils of forecasting and of the widely different forecasts which different people may arrive at after looking at the same portents. But we have been asked for our forecasts of the nuclear climate ahead and here they are.

We have made estimates both as to the costs and the amount of nuclear power. Let us consider these in turn.

Costs of Nuclear Power

The cost levels expected to be achieved by large nuclear power plants going into service at various times during the next twenty-five years are shown in the descending shaded area drawn on Chart A (attached). There are numerous complexities involved in talking about power costs, whether nuclear or conventional. It is not our wish to go into many of these here. However, it is necessary to arrive at some sort of a working definition of what we mean when we refer to nuclear power costs over a period of time, especially in relation to their competitiveness with costs from conventionally fuelled plants.

An essential point to remember is that a company which may be considering whether its new plant should be nuclear-fuelled or fossil-fuelled is interested in the cost performance of the plant over its useful life, not just at the start. Thus, the decision might be to build a nuclear plant even though it is not likely to be competitive at first because it seems inevitable that nuclear fuel costs will decrease over the next thirty years or more while conventional fuel costs seem likely to increase — slowly, we hope. Even if comparison over the life of the plant favours conventional fuels on the basis of best present-day cost estimates, a nuclear plant might be selected as a hedge against the possibility of unusually large future increases in conventional fuel costs.

We have attempted to illustrate some of these considerations on Chart A. In addition to estimates of power costs from large nuclear and conventional plants, shown in the shaded bands, there is an illustration regarding the factors underlying the decision to build a hypothetical nuclear Plant X.

A given utility may be interested in authorizing design and construction of the plant at time A shown on the chart. This plant will not actually come into operation until time B, three or four years later. As shown, intitial costs of operation at time B will be high due to the special problems involved in start-up of nuclear reactors. It is expected that costs will stabilize at a lower level after two or three years of operation, i.e. at time C as shown on the chart. Presumably this cost was predicted with a fair degree of assurance before the project was authorized (time A).

We have attempted to predict such stabilized costs as a function of the times when the various plants come into initial operation. This is indicated by point "X" on the chart. Such points are the ones to which we have reference in the cost estimates presented here and in the descending shaded band on the chart.

Following achievement of stabilized costs at time C, there is likely to ensue a long term slow decline in costs for Plant X, as shown by the Plant X line on the chart, due to a lower nuclear fuel cost. As indicated earlier, anticipation of such lower costs might prove influential in the decision to build the plant.

Let us now consider the stabilized costs expected to be achieved by large nuclear plants in general. In thinking of the genealogy of nuclear power we consider the plants which will go into service during the years 1957 through 1959 to belong to an experimental period during which there can be no hope of achieving costs competitive with modern conventionally fuelled plants in the

United States. Costs achieved by these early plants may range from about 20 to as much as 50 mills per kilowatt-hour.

The years 1960 to 1964 will bring what we consider to be the first generation of true industrial nuclear power plants. These plants will build on the technology and experience accumulated in the design, construction and operation of the earlier experimental plants, and may be expected to achieve lower costs.

As can be seen on Chart A, however, we do not expect plants in the first generation to produce power at costs competitive in the United States with the most advanced conventionally fuelled plants. Our estimate is that first generation nuclear plants, after their initial shakedown period, will achieve costs in the range of 10 to 13 mills per kilowatt-hour. We are assuming 1957 price levels, of course. Our estimate compares to present costs of electricity from modern coal-fired plants which are as low as 4½ mills in especially low cost fuel zones and range up to 9 mills in other areas. As of 1964 the costs from new coal-fired plants may have changed slightly but should still be in this approximate range.

Table 1. Nuclear Power Plants Expected to be in Operation by End of 1959

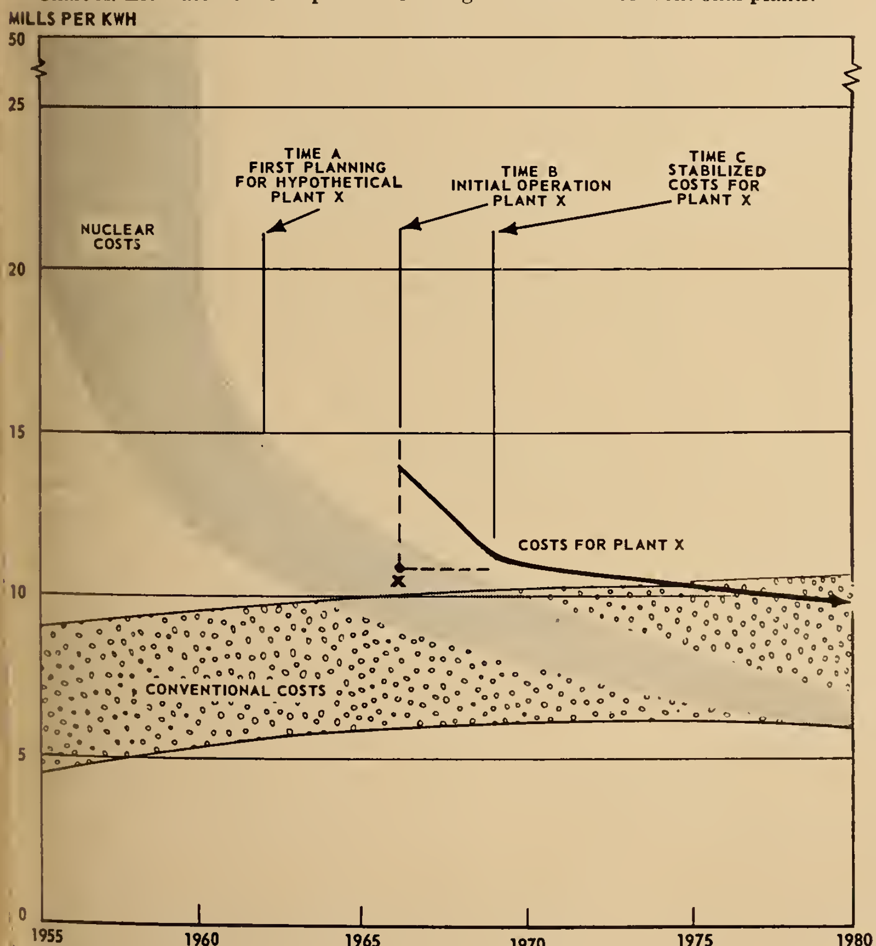
Name	Location	EKW (Thousands)
Federal Government-owned		
Pressurized Water Reactor (PWR)[2]	Shippingport, Pa.	100.0[1]
Boiling Water Reactor Experiment (EBWR)	Argonne Nat'l. Lab	5.0
Boiling Reactor Experiment No. 4 (BORAX-4)	NRTS, Idaho	2.0
Sodium Reactor Experiment (SRE)[2]	Santa Susana, Calif.	6.0
Homogeneous Reactor Experiment No. 2 (HRE-2)	Oak Ridge Nat'l Lab.	0.3
Experimental Breeder Reactor No. 1 (EBR-1)	NRTS, Idaho	0.2
Experimental Breeder Reactor No. 2 (EBR-2)	NRTS, Idaho	15.0
Army Package Power Reactor No. 1 (APPR-1)	Ft. Belvoir, Va.	2.0
Argonne Low Power Reactor (ALPR)	NRTS, Idaho	0.2
Privately Owned		
General Electric Co. & Pacific Gas and Electric Company	Livermore, Calif.	3.0
Total electrical kilowatts (thousands)		133.7

[1]Represents approximate expected capacity of second core. First core is expected to produce 60,000 EKW.
[2]Electric generating portion of plant privately owned.

The estimated discrepancy as of 1964 between power costs from nuclear plants and modern conventional plants is accounted for both by first capital costs and by operating costs, including primarily fuel cycle costs.

Capital costs for first generation nuclear plants are expected to range from $300 to $400 per kilowatt of capacity compared to costs for coal-fired plants which vary from about $115 to $180 per kilowatt, depending on location. Factors keeping nuclear plant costs high in this first generation include high costs for obtaining safety at a time when little factual information is available and the use of expensive materials because of lack of experience with cheaper substitutes.

Chart A. Estimated costs of power from large nuclear and conventional plants.



High fuel cycle costs may be expected for the first generation plants because of high fabricating costs and relatively short-lived fuel elements. A recognition of the importance of lowering fuel cycle costs is implicit in the terms of the third invitation under the Power Demonstration Reactor Program, which provide that assistance may be offered for research and development on fuel cycle problems as well as on the reactor plant itself.

Costs achieved from first generation nuclear plants may be low enough to be attractive in some countries abroad. The experience gained in supplying the foreign market will be a great help to American manufacturers in achieving further domestic cost reductions.

We consider a second generation of nuclear plants to be those which will go into service between 1965 and 1967. Capital costs for these plants may be expected to approach a competitive level with increases in plant size, more knowledgeable approaches to safety needs. and less costly materials. Fuel fabrication and fuel life problems may still require further solutions. Nevertheless, plants going into service toward the end of this generation, after their initial shakedown, should achieve costs in the range of from 9 to 11 mills. Considering the further cost reductions to be expected during the lifetime of the plants, they should be competitive with modern conventional plants in at least some parts of the United States.

Following the second generation, as Chart A indicates, we estimate that further cost reductions will take place, reaching a range of 6 to 7 mills by 1980. This would make nuclear power competitive with conventionally fuelled plants in all parts of the United States except a few locations with very low fuel costs.

Amount of Nuclear Power

By the end of 1959, we expect ten experimental plants to be producing nuclear power. Only one of these, however, the Shippingport pressurized water reactor, is a large scale plant, and our estimate of total nuclear generating capacity as of the end of 1959 is the order of only 130,000 kilowatts. These first nuclear plants with their expected outputs are listed in Table I, attached.

Intentions regarding certain of the installations for the years 1960 to 1964, which we consider to be the first generation of nuclear power plants, have already been announced. Other announcements are expected. We think some will undoubtedly come in response to the Commission's third invitation under the Power Demonstration Reactor Program which, among other requirements, specifies that proposals must be for plants able to produce power by June 30, 1962. Some additional plants may be built entirely with non-AEC financing, some entirely with AEC financing.

The first generation plants announced as of the end of February are listed in Table II. Adding to these the PWR and other experimental plants of 1957-59 vintage, and allowing also for an estimate of other plants as yet unannounced which may be undertaken for installation before the end of 1964, we have estimated a total installed nuclear capacity at that time of about 2.5 million kilowatts.

Toward the end of this first generation it is felt that a turning point may occur when a fairly large number of power producers and equipment manufacturers will become confident that plants can be planned and designed which will be economic when built and successfully operated over a long period of time during which coal and oil prices would be increasing slowly. This turning point may be partially psycholog-

Table II. Nuclear Power Plants Planned to Come into Service During "First Generation" (1960-1964)

Operating Organization	Location	EKW (Thousands)
Power Reactor Development Co., Inc.	Monroe, Mich.	100.0
Yankee Atomic Electric Co.	Rowe, Mass.	134.0
Consumers Public Power District	Beatrice, Neb.	75.0
Rural Cooperative Power Association	Elk River, Minn.	22.0[1]
Wolverine Electric Cooperative	Hersey, Mich.	10.0[1]
Chugach Electric Association, Inc.	Anchorage, Alaska	10.0
City of Piqua, Ohio	Piqua, Ohio	12.5
Commonwealth Edison Co.	Dresden, Ill.	180.0
Consolidated Edison Co. of N.Y.	Indian Point, N.Y.	236.0[2]
Pennsylvania Power & Light Co.	[3]	150.0
Florida Nuclear Power Group	[3]	200.0
Carolinas-Virginia Nuclear Power Associates, Inc.	[3]	10.0-30.0
Middle South Utilities, Inc.	[3]	20.0
New England Electric System	[3]	200.0
Northern States Power Co.	[3]	60.0
Ohio Valley Group	[3]	200.0
Pacific Gas and Electric Co.	[3]	[3]
Northwest Power Group	Near Hanford, Washington	[3]

[1]Approximately 80 per cent nuclear.
[2]140,000 kw. nuclear; 96,000 kw. oil-fired superheat.
[3]Not yet announced.

Table III. Derivation of Estimates of Nuclear Capacity (In millions of EKW)

	1	2	3	4	5	6	7	8
	Total Capability	Net Added	Retired	Gross Added (2)+(3)	Nuclear % of Total	Nuclear Installed* Added EKW	EKW	% of Total (7)/(1)
1956	122.0	5.7	0.7	6.4	....	....	....	...
1957	130.8	8.8	0.8	9.6	1.2	0.08	0.08	0.1
1958	144.0	13.2	0.9	14.1	....	....	0.08	0.1
1959	159.9	15.9	1.0	16.9	0.3	0.05	0.13	0.1
1960	175.3	15.4	1.1	16.5	4.1	0.67	0.8	0.5
1961	189.7	14.4	1.2	15.6	0.6	0.1	0.9	0.5
1962	204.2	14.5	1.3	15.8	2.5	0.4	1.3	0.6
1963	219.2	15.0	1.4	16.4	3.0	0.5	1.8	0.8
1964	235.0	15.8	1.5	17.3	4.0	0.7	2.5	1.1
1965	251.7	16.7	1.6	18.3	8.2	1.5	4.0	1.6
1966	270.2	18.5	1.7	20.2	8.4	1.7	5.7	2.1
1967	290.5	20.3	1.8	22.1	8	1.8	7.5	2.6
1968	312.3	21.8	1.9	23.7	13	3.1	10.6	3.4
1969	335.5	23.2	2.0	25.2	20	5.0	15.6	4.6
1970	360.3	24.8	2.1	26.9	26	7.0	22.6	6.
1971	386.2	25.9	2.3	28.2	32	9.0	31.6	8.
1972	413.1	26.9	2.5	29.4	38	11.2	42.8	10.4
1973	441.0	27.9	2.7	30.6	43	13.2	56.0	12.7
1974	469.9	28.9	2.9	31.8	48	15.3	71.3	15.
1975	500.0	30.1	3.1	33.2	53	17.6	88.9	17.
1976	532.7	32.7	3.4	36.1	57	20.6	109.5	20.
1977	568.9	36.2	3.7	39.9	60	23.9	133.4	23.
1978	608.7	39.8	4.0	43.8	63	27.6	161.0	26.
1979	652.3	43.6	4.3	47.9	65	31.2	192.2	29.
1980	700.0	47.7	4.6	52.3	67	35.0	227.2	32.

*Cumulativ

Sources:

Column 1—Class I system only: 1955 actual; 1956-1960, 1965, 1970 from *Electrica World* 9/17/56. Intervening years and 1971-1980, Division of Reactor Development

Column 3—1955-70 total *Electrical World*. 1970 figure, *Electrical World*. Interven ing years and extrapolation to 1980 by Div. of Reactor Development.

Column 5—1967-80, Div. of Reactor Development. Prior to 1967, Col. 6/Col. 4

Column 6—1957-62—Presently planned projects.

1962-66—Estimated by DRD to provide smooth curve.

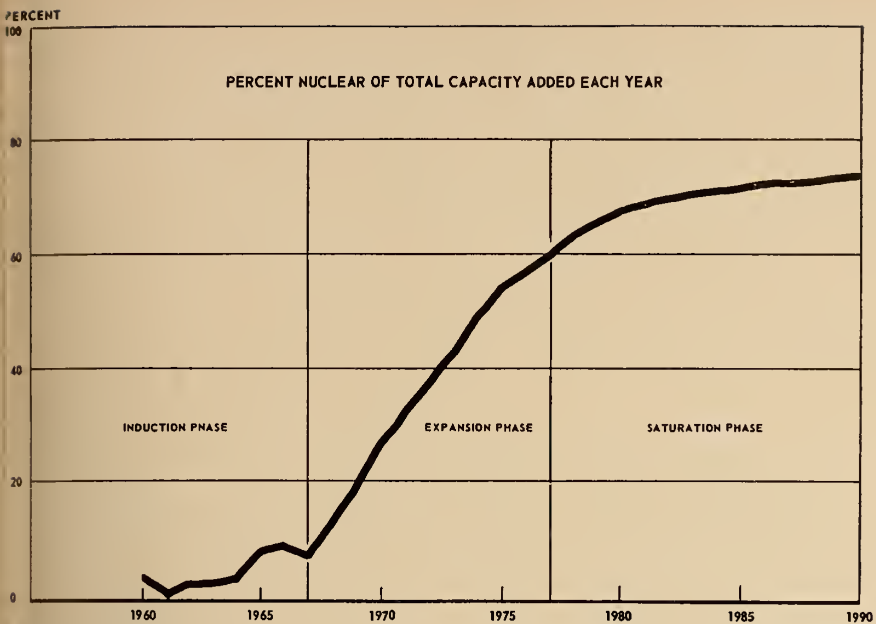
1967-80—Resultant Column 4 x Column 5.

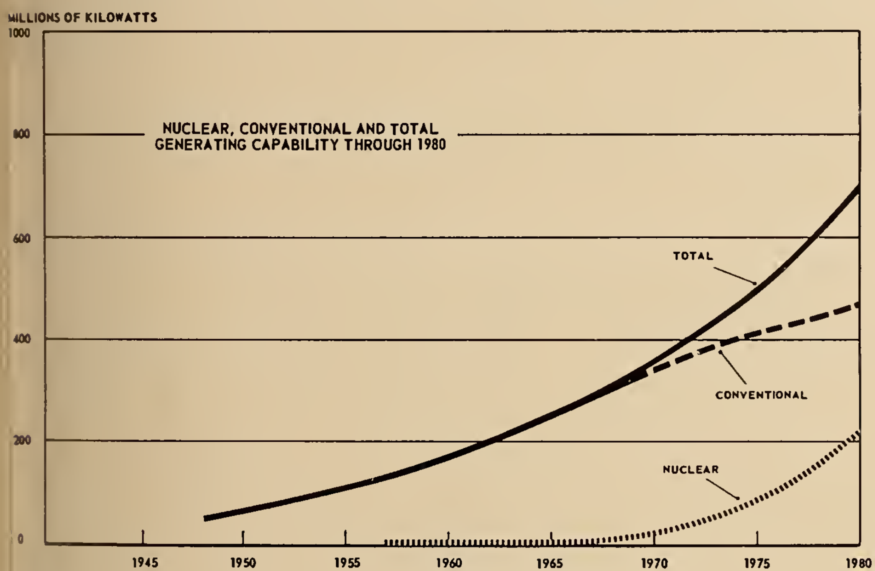
Column 2, 4, 7 and 8—Derived from other columns.

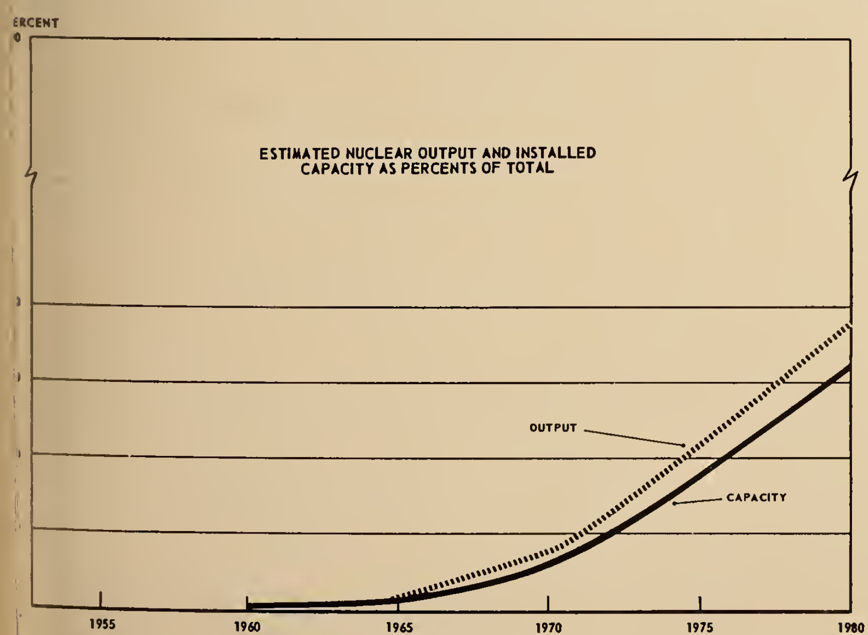
Table IV. Forecasts of Installed Nuclear Capacity (1960-1980, in millions of Electric Kilowatts)

	1960	1965	1970	1975	198
Current Estimate	0.8	4.0	22.6	88.9	227.
W. K. Davis, 1955[1]	0.8	4.5	27.0	83.0	175.
James Lane, ORNL	0.5	..	12.0	....	42.
McKinney Panel Report:					
Upper range	0.8	4.0	9.0	45.0	135.
Lower range	0.8	3.0	9.0	20.0	52.
B. R. Prentice (General Electric Co. for McKinney Panel)	0.8	4.0	12.3	48.0	137.

[1]Repeated in testimony at 1956 Section 202 Hearings before Joint Committee o Atomic Energy.







ical in nature, although based to a considerable extent on scientific and engineering judgment.

Because of the lead time required between first planning and final completion of a nuclear power plant, several years will elapse before this turning point takes effect. After this period of time, however, we expect that the percent of total installations which is nuclear-fuelled will begin to increase. We conceive the curve of nuclear installations as percents of total to appear as represented in Chart B. It will be seen that an expansion phase is expected beginning in 1967 when added nuclear capacity is estimated as 8 per cent of total additions. Thereafter, this percentage should begin to increase sharply until in 1980 two-thirds of all capacity added will be nuclear. Thereafter the rate of increase may be expected to decline as a near-saturation point is reached. The non-nuclear portion may be expected ultimately to hold steady at about 25 per cent of capacity added each year, in the form of hydro plants, very small plants or plants located where fossil fuel costs are very low.

On the basis of these key expectations it has been fairly simple, with some further assumptions, to arrive at estimates of installed nuclear capacity for various dates in the future. The derivation of these results is shown in Table III.

The estimates shown in column 1 of the table for total capability are based on forecasts made in September 1956 by *Electrical World* Magazine. Those forecasts carried through 1970 and we have extrapolated them through 1980. It should be noted that this *Electrical World* forecast is at a higher level than those which have been made before and which formed partial bases for previous AEC forecasts about nuclear power.

As will be seen on Table III, we arrive at estimates of nuclear capacity which may be summarized as:

Estimated Nuclear and Total Utility Generating Capability (1955-1980, in millions of electrical kilowatts)

Year	Total Capability	Nuclear Capability	Nuclear as % of Total
1955	116.3	....	......
1960	175.3	0.8	0.5
1965	251.7	4.0	1.6
1970	360.3	22.6	6.3
1975	500.0	88.9	17.8
1980	700.0	227.2	32.5

These results are seen in Chart C.

Charts B, C, D (top to bottom).

Our forecasts of *energy* output from nuclear plants involve slightly higher percentages of totals than do the above capacity estimates. This is shown in Chart D. The reason for the difference is that nuclear plants may be expected to operate at higher average load factors than the average of conventional plants. The estimates for output at specified years are as follows:

Estimated Nuclear Output Related to Total Utility Output
(1955-80, in billions of kilowatt hours)

Year	Total Utility Output	Nuclear Output	% of Total	Average Load Factor
1955	546.3	....	....	....
1960	811.9	2.4	0.3	60%
1965	1175.8	22.8	1.9	80%
1970	1700.1	133.9	7.8	80%
1975	2400.0	526.3	21.9	75%
1980	3400.0	1285.9	37.8	70%

Our estimates of long-range future nuclear capacity and output are somewhat higher than those we made two years ago and substantially higher than those made by some of our fellow forecasters. Table IV compares some of these estimates.

To a large extent, these higher estimates are explained by higher expectations regarding total utility installations, both nuclear and non-nuclear. In the percentage of total capacity added each year our estimates are more nearly comparable to those made by others, as shown in Table V.

Table V. Forecasts of Nuclear Additions Each Year as per cent of Total Additions 1965-1980

	1965	1970	1975	1980
Current Estimate	8	26	53	67
W. K. Davis, 1955	8	38	60	70
McKinney Panel Report				
Upper range	..	5	41	63
Lower range	..	10	45	65
B. R. Prentice (General Electric Co. for McKinney Panel)	6	12.5	41	62

Conclusion

This is a period of some discouragement with respect to the cost of building and operating power reactors. After the excessive optimism of two or three years ago, we are at grips with the hard realities of developing and building real nuclear power plants. This does not turn out to be an easy task. There are many difficulties and the way ahead is not wholly clear.

However, just as it was unfortunate to have had this over optimism two or three years ago about 4 and 5 mill nuclear power, it would be equally unfortunate to let the present frustrating but not unexpected engineering difficulties lead us to undue pessimism about the future of nuclear power in the United States.

Some years from now, we believe that nuclear plants will have higher capacities than the present conservative designs permit and that they will be built more simply and more cheaply. We believe also that we will find ways of making fuel elements of long life cheaply and with adequate reliability. Some of this, perhaps the major part, will be accomplished simply by dogged engineering development work. The rest will come from the new ideas and inventiveness which have ever characterized the advance of technology in the United States.

These advances will take time, money, facilities, and, most importantly, they will require the best engineers and scientists working in the most effective manner. We acknowledge that in the light of present day knowledge the estimates we have presented may appear optimistic. They depend upon vigorous and successful prosecution of the present development program. They assume a fertile climate for the growth of a nuclear power industry in the United States. The history of similar developments in the past fully justifies our optimism.

We must be realistic about the task that lies ahead and the problems which must be solved. Let us be optimists — but realistic optimists. We believe that the task can be and will be accomplished.

Proceedings of the 1957 Nuclear Congress

(Special Rate to E.I.C. Members)

The Proceedings of the 1957 Nuclear Congress, held in Philadelphia, Pa., in March, is to be available on 15 August in three volumes. The regular publisher's price is $45, but the American Society of Mechanical Engineers (the managers of the Congress), in view of the publication date of this issue of the *Engineering Journal*, have extended to members of the Engineering Institute of Canada (a sponsor of the Congress) the opportunity of obtaining these Proceedings at the pre-publication price of $35, if they apply through the Engineering Institute before 30 August, 1957.

There are two volumes covering Advances in Nuclear Engineering, and one volume on Hot Laboratory Operation and Maintenance. These are concerned with the following subjects:

Advances in Nuclear Engineering

Volume I (62 contributions) — Manufacture, production, recovery, and economics of nuclear fuels; spent fuel processing; plant containment concepts and design; plant components; waste disposal; protection and safety measures; radiation processing.

Volume II (73 contributions) — Reactor design; reactor core design; operation and maintenance of reactors; metallurgy; heat transfer and heat evolution; educational uses of reactors; standardization planning in the nuclear field.

Hot Laboratory Operation and Maintenance

Volume III (61 papers) — Equipment for hot chemical, physical, mechanical, and metallurgical operations; hot cell installations; hot laboratory facilities; operation and administration; specialized hot operations.

A resume of the international outlook for atomic power and the highlights of the 1956 meeting of the American Nuclear Society are also given.

(A list of the papers given at the Congress appears on pages 1139-1140 of this issue.)

Remote Handling Facilities at Chalk River, Ontario

A. S. Bain

Atomic Energy of Canada Limited, Chalk River, Ont.

A REMOTE CONTROL handling cell was built by Atomic Energy of Canada Limited at Chalk River, Ontario to complement a program of (a) fundamental research on the effect of radiation on the properties of materials, and (b) the development of fuel elements for future reactors. The cell was installed when the metallurgy building was constructed in 1954. Active operations commenced in October 1955.

Description of Cell

A general layout of the cell and surrounding rooms is shown in Figure 1. Figure 2 is a photograph showing the front face of the cell and, on the right, a horizontal flask being fitted against the loading port on the end of the cell. Figures 3 and 4 show the construction details more fully.

The room in which the cell is ocated is 21 ft. wide, 36 ft. long and 24 ft. high. The floor of the room is six inches of concrete covered with asbestos tile. The pressure in the oom is maintained slightly lower than hat in the corridor; i.e. there is always a flow of air into the room. The xhaust air from the room is not filtered, but passes directly into the main ventilation ducts of the metallurgy building.

The inside dimensions of the cell re 10 ft. long, 6 ft. deep and 12 ft. igh. The front and side walls are menite concrete two feet thick. The oncrete was poured into a welded ame of ⅜ in. mild steel plate, nd the steel left in place after the our. The back wall is an eight inch ick steel plate in which there is a ft. high by 6 ft. wide opening. The of of the cell is reinforced ilmenite oncrete, one foot thick. The ilmenite oncrete, of density approximately 3.3 gm./cc. was made by adding ilmenite, $FeO.TiO_2$, and magnetite, Fe_3O_4, to a concrete mix, and it has the chemical composition shown in Table I.

The floor of the cell is one foot of ordinary concrete poured on bedrock This is covered with a ½ in. thick mild steel plate which is welded to the inner walls of the cell. In a rear corner there is a 15 in. diameter by 12 in. deep sump.

There are two 8 ft. high by 4 ft. wide by 8 in. thick steel doors covering the opening in the back wall. These doors, each of which weighs 5¼ tons, slide together manually and meet in the centre in a tongue and groove joint.

The construction, operation, and approximate cost of an intermediate level remote control handling cell are reported in this paper. Shielding experiments using Co^{60} sources are described.

The four windows are made of dense, 3.3 gm./cc., non - browning glass. The two front windows are both made in a stepped construction of three sheets, each 8 in. thick. (See Figures 3 and 4.) The largest, or inside, sheets are 35 in. x 40 in. The window on each end is 24 in. x 34 in. x 18 in. thick, constructed of two sheets 9 in. thick. All the windows are mounted dry, (without oil seals or moisture traps). All windows are covered, inside and outside the cell, with a ¼ in. thick sheet of lucite.

Table I. Chemical Composition of Ilmenite Concrete

	wt. %
Fe	39.5
Ti	14.7
O	35
Si	3.5
Al	2
Ca	3
Mg	1.5
H + C	<1

Spaced at intervals around the walls are thirty horizontal holes of 4 inch diameter, and two holes of 9 in. diameter (See Figures 3 and 4). The holes were formed by welding lengths of 4 in. or 9 in. pipe in the steel frame before the concrete was poured. Normally the holes are kept plugged with 24 in. long cylinders made from two inches of lead plus twenty-two inches of aluminum. The cylindrical plugs can be removed to extend operating mechanisms through the cell wall. Some of the cylinders have spiral grooves milled in them to bring electrical leads or flexible tubing through the wall.

Illumination is provided by sodium vapour lamps. There are eight 140-watt bulbs and six 45-watt bulbs. In addition, six incandescent lamps are connected to an emergency power supply.

There are three exhaust ducts in the cell, one on the ceiling and two half way down the wall in the rear corners. The system is exhausted by a 1000 c.f.m. fan. The exhaust air passes through an absolute filter immediately after leaving the cell and then enters the main ventilation ducts of the building. In addition, there is a complete stand-by system which operates on emergency power, and is wired to start automatically whenever the other fan is shut off. This emergency system, which is exhausted by a 250 c.f.m. fan, branches off the regular cell ventilation system through a separate filter and exhausts to the atmosphere.

The services for the cell are contained in a panel which runs along the front and two side walls. Services available are 110 volt and 220 volt normal power, 110 volt emergency power, 110 volt direct current power, high pressure air, water, steam, and propane gas. There are no service outlets inside the cell.

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ad at the 1957 Nuclear Congress, Philaphia, Pa., (see pp. 1128, 1139)

The cell is equipped with one pair of Argonne model 8 master-slave manipulators. The through tubes are mounted at a 28 in. centre-to-centre distance on a three inch thick steel plate which can slide across the front of the cell.

At one end of the cell a through-the-wall stereomicroscope-camera is installed. It is possible to view specimens at magnifications of from 1x to 90x, or to take stereo-photographs on a 5 in. x 7 in. film plate. Specimens are mounted on a staging which is directly below the objective lenses of the microscope. The staging is used for focusing and locating the specimens. There are five separate motions, all of which are controlled by the operator as he looks through the microscope.

A half-ton pneumatic hoist is installed inside the cell on a two-way moving trolley.

The inside surface of the cell is coated with a heavy layer of paste wax, then lined with polythene sheet.

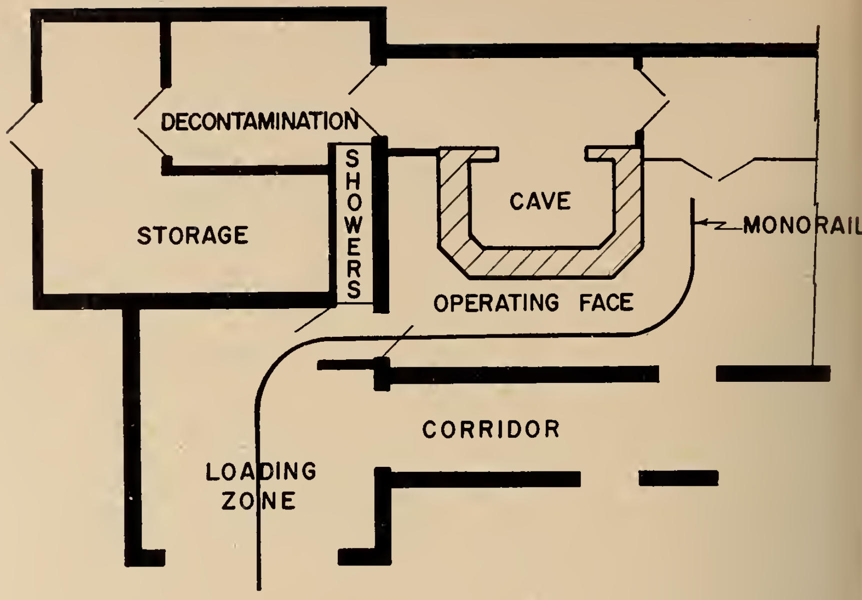
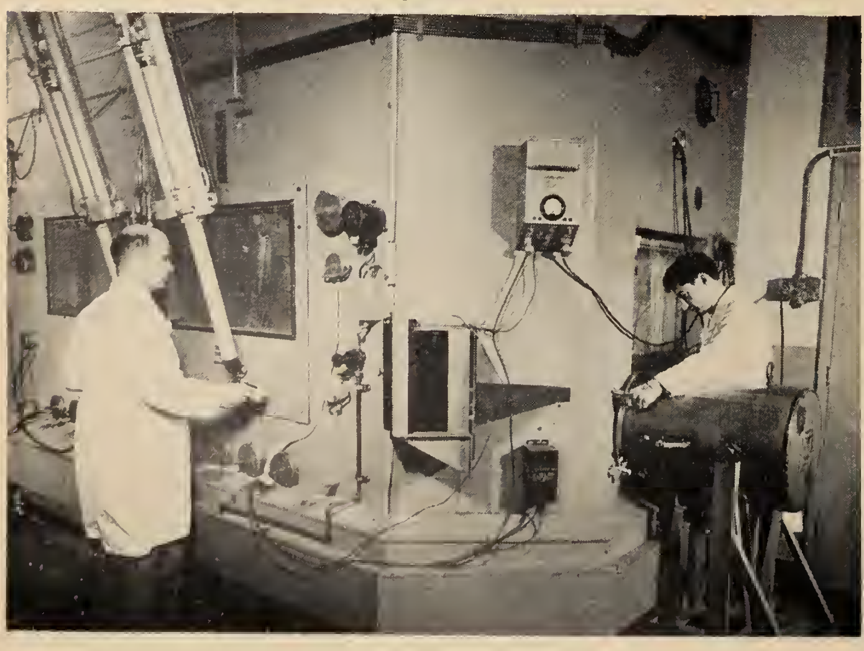


Figure 1.

Procurement and Transportation of Samples

Specimens which are examined in the cave have been irradiated in the NRX reactor. This reactor and its radiation facilities are described by Hurst & Ward.[2] Connected to NRX is a system of trenches in which fuel rods are handled, desheathed, or sectioned under ten feet of water. In these trenches, specimens for examination are removed from their in-pile components and put into the drawer of a lead-filled flask. The flasks are lifted out of the water, allowed to drain, then brought by truck to the metallurgy building. A hoist and monorail are used to transport the flask from the unloading platform to the unloading port at the end of the cell. The drawer, which has six inches of lead shielding on each end, is pushed from the flask, through the wall of the cell and on to a shelf inside the cell. The specimen is then removed from the drawer with the manipulators. Two different flasks, both of which will fit against the unloading port, are available: one has six inches of lead shielding and will hold a 2.5 in. square specimen 11.5 in. long; the other has eight inches of lead shielding and will hold a 14.5 in. long specimen of similar cross-section. Another flask with eight inches of shielding is being constructed to permit the transport of samples up to 2.5 in. square and 32 in. long. Specimens which will not fit in any of these flasks must be put in suitable flasks which are then manually wheeled inside the cell.

Figure 2.



Storage of Specimens

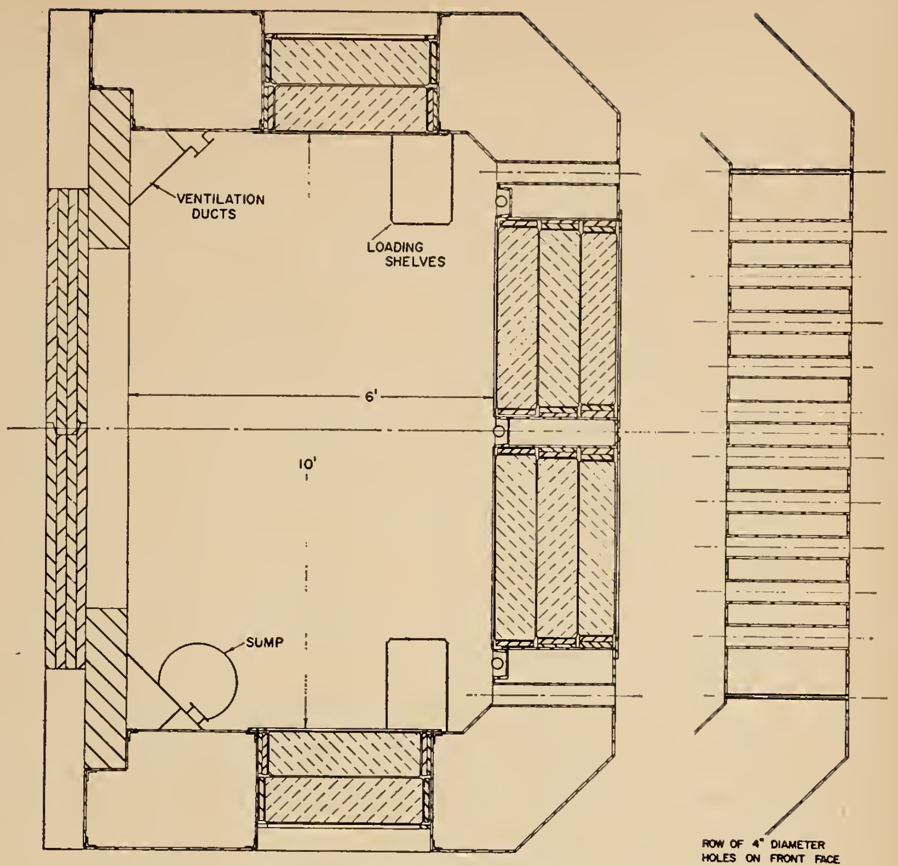
There are six storage wells, each ten feet deep, in a separate room near the cell. Each well is lined with a stainless steel insert which has two compartments designed to accommodate the drawer and flask liner from the six inch shielding flask The flask is wheeled to the storage room where it is lifted off the trolley and swung into a vertical position The flask is lowered until a boss on the end mates with a similar shaped hole in the top plate of the storage well insert. The drawer and flask liner are then lowered into the storage well. Figure 5 shows one well with two drawer and liner assemblies The largest specimen which may b stored in the wells is 2.5 in. squar and 11.5 in. long.

There is a 3 ft. wide by 4 f deep by 10 ft. long storage troug in the same room. This trough i above floor level and is surrounde by twelve inches of ordinary con crete shielding.

Operation of Cell

There are four people assigne directly to the cell program. Th professional man looks after scheduling all work, writing necessary reports, checking design of all equipment to be used inside the cell, and generally supervising operations in the cell. The three technicians do most of the work with the manipulators as well as developing and printing all the photographs taken with the stereo-camera. The cell is normally operated one shift per day, five days a week. If any new apparatus is being used, a dummy run is made, if possible. Persons requesting work done in the cell assist in making observations and recording data, but all work with the manipulators is done by personnel assigned to the cell program.

Equipment for a job is installed in the cell, then after the job is completed, the equipment is removed, washed and stored in an adjoining room, (See Figure 1). An operator, when entering the cell to change equipment wears cotton overalls covered by a plastic suit which has moulded feet and double sleeves. He wears a fresh-air type respirator and a clear plastic hood. Finally, he puts on two pairs of rubber gloves which are taped to the sleeves of the plastic suit, and steel-toed rubber boots. When leaving the cell he showers with the plastic suit on, then steps into an undressing chamber where his clothes are removed. He then showers in a second stall, after which he dons fresh clothes. Since all personnel are allowed only 5 roentgens per year total body radiation, it is necessary to bring in men from the labour crew to assist when the cell is being decontaminated. During the past year the cell has been shut down for decontamination approximately two weeks in every three months.



CELL PLAN 4'-4½ ABOVE CELL FLOOR

Figure 3.

The cell and associated equipment have been relatively free from break down. Since active work started, the cell has had three one-day shutdowns to replace broken tong cables in the manipulators.

Equipment

The following equipment is available for use inside the cell: micrometers and verniers, hardness tester, bend strength tester, impact tester, portable tensile tester, stud welder, lathe, micro drill press, density measurement apparatus and profilometer. A cut-off wheel, desheathing saw, tensile tester, and micro-profilometer are on order and will be available for use soon.

With the aforementioned equipment and method of handling specimens it has been possible to remove a test section fom the reactor and examine it in the cell, then assemble and reinsert it in the reactor during a three-day reactor shut-down.

Cost of Cell Facilities

Since the cell and storage facilities were built along with the Metallurgy Building it is difficult to determine their construction costs. The costs of equipment purchased and the internal charges levied by A.E.C.L. for services, such as machinist and millwright work etc. have been recorded, however, and are shown in Table II. Also given in Table II is an estimate for the construction cost of the bare cell and its services, the storage wells and trough, and the equipment storage, decontamination and shower facilities. Costs shown in Table II are direct costs and do not

Table II. Approximate Construction and Equipment Costs for the Cell

A. Construction Costs (*Including basic equipment*)	$	
Concrete and steel shell plus storage room*	50,000	
Shielding windows, steel doors, manipulators and sliding shield, monorail and hoists.	50,000	
Lighting and ventilation	6,000	
Radiation monitoring system	3,000	
	$ 109,000	$ 109,000
B. Extra Equipment Costs	$	
Extra set of manipulators	8,000	
Lead filled flasks and storage drawers	14,000	
Special equipment, stereomicroscope, physical testing apparatus, lathe etc.	31,000	
Work done by A.E.C.L. services for construction and installations of equipment	10,000	
Total	$ 63,000	$ 63,000
		$ 172,000

* This $50,000 estimate includes the bare concrete and steel shell, the storage wells and trough, and the shower, decontamination, and equipment storage facilities.

include overhead or salaries of personnel assigned to the cell program.

Shielding of Cell

Experiments using calibrated Co^{60} sources * were carried out to determine the shielding properties of the concrete and the windows.

The sources were cobalt pellets contained in aluminum capsules which were ¾ in. diameter by 1⅜ in. long. The counter was a Tracer Lab Radiation Survey meter model SU1D, and was calibrated just prior to the experiments by the Radiation Hazards Branch of A.E.C.L., using a standard Co^{60} source.

The source strengths were as given in Table III

A. Radiation through Components of Cell — The radiation transmitted through the concrete walls, the front and end windows, and the steel doors, when the source was in contact with the inner surface and the meter in contact with the outer surface are given in Figures 6 and 7.

B. Build-up Factor of Ilmenite Concrete and 3.3 Density Glass — The build-up factor is defined as the ratio of the actual gamma flux to that which would be calculated using the simple exponential expression $I = I_o \exp.(-\mu t)$ where μ is the linear absorption coefficient, and t is the thickness of the shielding material. The measured and calculated values of gamma flux differ because the calculated linear absorption coefficients are based on narrow beam geometry and thin sections of absorbing material so that any photon which is deflected once is deflected out of the beam, whereas, in actual practice, using finite shielding slabs, a photon which is deflected once is not necessarily stopped from passin; through the shielding. The main pro cesses for the build-up of radiatio due to scattering and secondary emis sions are Compton scattering, photo electric effect and pair productior Theoretical methods of determinin the build-up factors have been de veloped,[3] and tables for variou shielding materials are available.[4,5,6,7] However, no experimental data ar available for ilmenite concrete an 3.3 density glass. Calculations usin the data plotted in Figures 6 and .

* Sources were supplied by Industrial Operations Division, A.E.C.L.

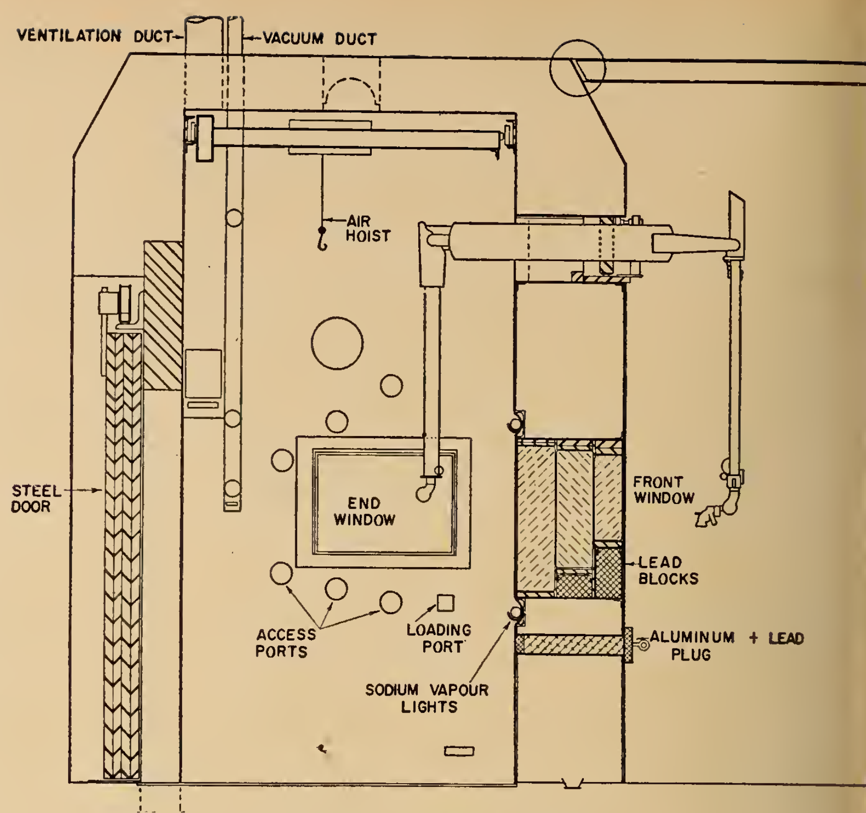
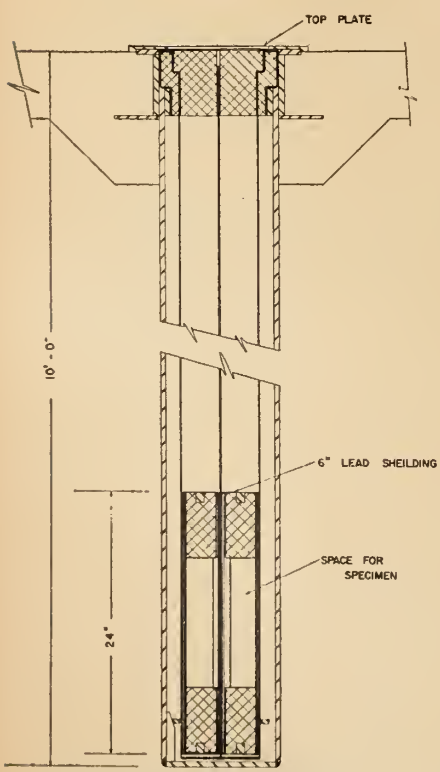


Figure 4 (above). Figure 5 (below, left).



STORAGE WELL ASSEMBLY WITH TWO DRAWERS IN PLACE

Table III. Co^{60} Sources, Used in Shielding Experiments.

Source Strength	Accuracy	Radiation at 1 Metre
14 curies	± 10%	Not measured
50 "	± 10	"
100 "	± 5	"
235 "	± 5	315 R/hr.
1015 "	± 5	1352 R/hr.
1080 "	± 5	1450 R/hr.

Table IV. Build-up Factors for Ilmenite Concrete and 3.3 Density Glass Using Co^{60} Radiation

Shielding	Build-up Factor
23⅝ in. of 3.3 density glass	7.0 — 9.0
18⅛ in. of 3.3 density glass	3.5 — 5
23¼ in. of ilmenite concrete	5.0 — 7

Table V. Strength of Various Gamma Energy Sources to Give 0.6 mr/hr. Fiel Through the 3.3 Density Glass Windows on the Front Face of the Cell

Gamma Energy	Source Strength
Co^{60}	10 curies
1 Mev.	70 "
0.9 Mev.	136 "
0.8 Mev.	415 "
0.7 Mev.	1110 "

gave the build-up factors listed in Table IV.

Calculations were made using the formula reported by Rockwell.[6]

$$\frac{B.\ DK4\pi\ x^2}{S_0 \exp.(-\mu t)} \quad (A)$$

where

B = build-up factor (dimensionless)

D = dose rate (R/hr.)

S_0 = point source of gamma rays (photons/sec)

K = conversion factor from gamma ray flux to dose rate

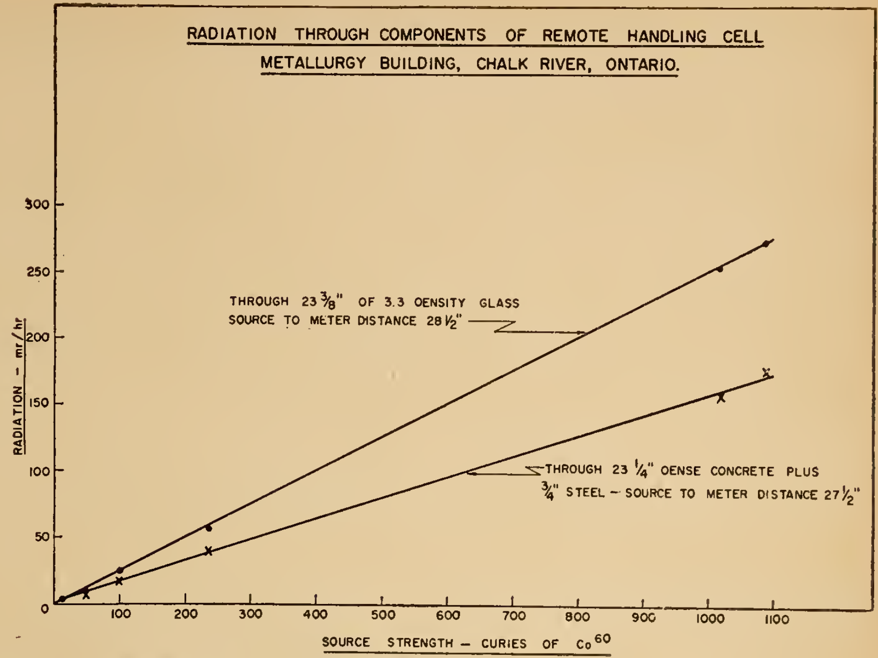
μ = linear absorption coefficient (reciprocal length)

t = thickness of shield (length)

x = distance from source to detector (length)

The following are assumptions:

(1) Radiation emanated from a point source.



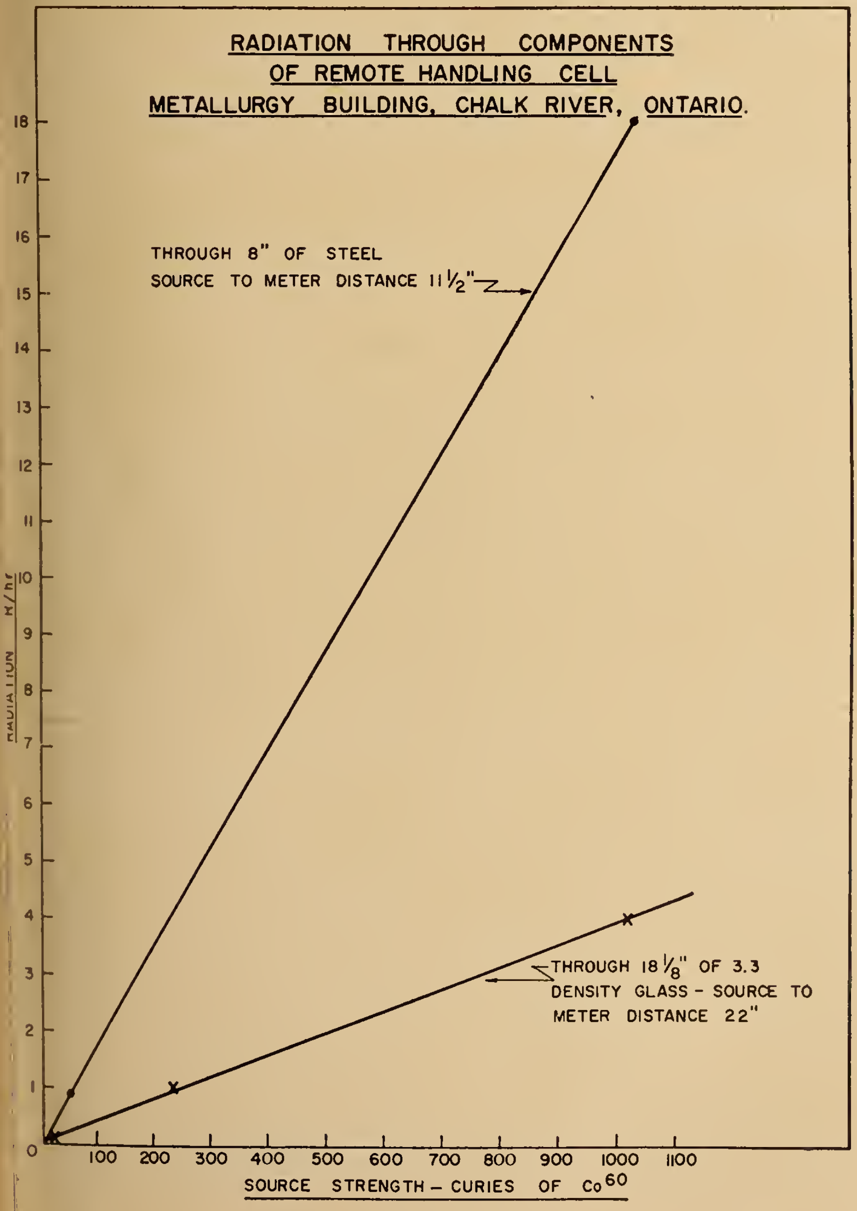


Figure 6 (above). Figure 7 (below).

(2) Co^{60} emitted two gamma rays of 1.25 Mev. each, instead of one of 1.17 Mev. and one of 1.33 Mev.

(3) The linear absorption coefficient of ilmenite concrete is 0.47 per inch[2] and 3.3 density glass is 0.48 per inch for 1.25 Mev. radiation.[8]

C. Allowable activity in cell — Since the allowable total body irradiation at Chalk River is 100 milli-roentgens per week, averaged over one year, the maximum field outside the cell should not be higher than 3 mr/hr., based on a 33 hour work week. This latter figure, however, would not allow any time for working inside the cell, where the residual activity is approximately 100 to 300 mr/hr. Therefore, a safety factor of five is used, bringing the maximum permissible field outside the cell to 0.6 mr/hr. From the slope of the curve in Figure 6 the source strength which produces 0.6 mr./hr. radiation outside the front windows is 2.3 curies of Co^{60}. This is a pessimistic figure, since it is calculated with the source and meter in contact with the inner and outer surface of the windows respectively. In normal operation, the source to operator distance would not be less than four feet, or twice the window thickness. Therefore the source strength to give 0.6 mr/hr. field on the outside of the cell would be approximately 10 curies of Co^{60}. The source strength to give 0.6 mr/hr. for other gamma energy radiation can be calculated from equation (A),

(Continued on page 1138)

The International Outlook for Atomic Power

Paul F. Foster

Assistant General Manager for International Activities, U.S. Atomic Energy Commission.

Delivered at the All Congress Banquet of the Nuclear Congress, Philadelphia, Pa., 13 March, 1957

I HAVE CHOSEN AS MY topic for tonight, "The International Outlook for Atomic Power", which could take hours, but about which I hope it may be possible for me to say something worthy of your time and consideration in less than half an hour.

A realistic appraisal during your first Nuclear Congress, a year ago in Cleveland, would not have been nearly so encouraging as one that can be made now. There have been great developments during the past year in the field of atomic energy and also there have been international political events that have influenced the thinking of governmental and industrial leaders throughout the free world. You will recall that the closing of the Suez Canal last October emphasized the fact that today petroleum for Europe is as much a political weapon as it is a commodity in international trade. A clearer realization of this grim fact undoubtedly has accelerated atomic power programs in both England and Europe.

An increased confidence in the prospects for atomic power has been engendered in this country during the past year by the announcement of plans or commitments for a number of large-scale atomic power projects in the United States; by contracts that have been placed with United States firms for the construction of three small atomic power plants for Latin America; by serious negotiations that American manufacturers have in progress for the construction of large atomic power plants in Italy and Japan and for smaller plants in Belgium, Taiwan, the Dominican Republic, and the Philippines; and by Congressional approval for the construction of an atomic powered merchant ship.

The outlook for atomic power was brightened just a week ago yesterday by the announcement in the House of Lords of a bold program to triple Britain's planned production of atomic energy for industry by 1965, notwithstanding the fact that this program, admittedly, would put a very heavy burden on her capital resources at a time when they are to be seriously strained by other requirements.

The new British program as outlined by Lord Mills, Minister of Power, calls for the construction in the next nine years of sixteen atomic power stations in England, Scotland, and Wales and one in Northern Ireland, in addition to the three stations now under construction as part of the program authorized in 1955. Lord Mills stated that the new program would provide at least 5,000 megawatts of atomic power by the end of 1965, but he added that, ". . . if technological development continues to be favourable and the necessary physical and financial resources can be found, a figure of 6,000 megawatts can be achieved by that date." The cost of building the new atomic power plants is estimated at about 2 billion and 77 million dollars. The initial fuel charges for new reactors will cost an estimated additional 496 million dollars thus bringing total initial capital costs up to about 2 billion 573 million dollars at current prices.

The press accounts of the British announcement included the very significant statement that the costs of the atomic power plants would be more than double that of conventional power stations. This, I might add, is indeed a very large premium to pay for atomic power, but a full year's operation of Britain's twenty atomic power stations would save 18 million tons of coal. As you know, coal is Britain's principal natural resource and it is in diminishing supply and its price trend is upward.

From a study of London newspapers carrying the story of Lord Mills' announcement and the discussions that ensued in the House of Lords, I gleaned some informative data that may be of interest to this audience.

1. British estimates of costs for their new atomic power program are based on an average figure of $346 per kilowatt of installed electric power and on the assumption that a capacity of 6,000 megawatts will be reached. If, however, a capacity of only 5,000 megawatts is reached the cost per kilowatt would be $415. These estimates do not include the costs of the initial fuel charges for the reactors.

2. Costs of the new atomic power stations now being built at Berkeley and Bradwell are estimated at $386 per kilowatt of installed electric power, without initial fuel charges; the Berkeley station will have a capacity of 275,000 kilowatts and Bradwell a capacity of 300,000 kilowatts.

3. The cost of a 150,000 kilowatt atomic power plant to be built in Northern Ireland is estimated at 70 million dollars, or about $467 per kilowatt of installed electric power; this estimate apparently includes the cost of the initial fuel charges.

These new estimates of British

costs for atomic power stations appear to be materially higher than the estimates of costs for the Yankee pressurized water type reactor and the Dresden boiling water type reactor both of which use slightly enriched uranium as fuel instead of natural uranium as in the gas-cooled Calder Hall type reactor.

In connection with the announcement, the London *Times* of March 6 quoted Sir Edwin Plowden, Chairman of the United Kingdom Atomic Energy Authority, as having stated in a press conference on the day before that within the period covered by the program it would be possible to proceed to reactors of the Calder Hall type using slightly enriched fuel and that the effect would be to reduce the capital cost of nuclear power stations, but to add slightly to fuel costs.

I should like to comment on this authoritative British statement about the advantages of slightly enriched uranium over natural uranium as a reactor fuel. The principal advantage relates to the physical characteristics and the savings in construction costs made possible by the use of smaller reactors for a given installed capacity. An improved 150,000 kilowatt Calder Hall type reactor is estimated to require some 250 tons of natural uranium, whereas the 134,000 kilowatt Yankee pressurized water reactor in Massachusetts will use only about 25 tons of uranium enriched to 2.7% and the 180,000 kilowatt Dresden boiling water reactor in Illinois will use only some 60 tons of uranium enriched to 1.5%.

While I am drawing comparisons between the initial capital costs of reactors of different designs, I should add that operating costs after start-up are often a more important factor. There have been many conflicting statements in the press, on the radio, and on television in recent months about the operating costs of gas-cooled natural uranium reactors of the improved Calder Hall type compared to the operating costs of pressurized water and boiling water reactors using slightly enriched uranium as fuel. The methods of calculating cost of power in this country are not the same as those used in many other countries, particularly those with nationalized power. I shall not attempt tonight to go into the details of this complex issue, but I do want to call attention to the need for each country to place such comparisons in its own frame of reference with respect to initial capital charges for plant and equipment, costs of fuel, charges for taxes, depreciation, amortization, interest rates on domestic and foreign loans and credit allowed for plutonium produced in the reactor. All these are factors that significantly effect the calculations of cost of power at the bus bars.

Let us now take a look across the English Channel at the prospects for atomic power on the Continent. Although the need for a new source of energy is generally as pressing in Europe as it is in Great Britain, the progress toward atomic power has been slower in France, Germany, Italy, Belgium, Luxembourg and the Netherlands. However, these six nations are joined by strong economic ties in the Coal and Steel Community, and they are now nearing final, formal agreement for the pooling of their efforts in the atomic energy field. As you know, this joint enterprise, known as Euratom, has reached the point where a treaty has been signed by the Foreign Ministers of the six nations involved. The Heads of State expect to sign the treaty in Rome on March 25 and to submit it promptly to their respective Parliaments for ratification during the early summer.

The author reviews the current nuclear energy developments that are under way in various parts of the world, particularly in relation to the high degree of co-operation that will be necessary between Britain, the Euratom countries and the United States. Competition will also be keen.

You have heard the message read to you by Mr. Iddles from Mr. Etzel, vice-president of the Coal and Steel Community and a member of the Committee known as the "Three Wise Men" who visited this country last month. It will not be necessary for me to explain the task assigned to the Committee nor to elaborate on Euratom's need for atomic power on a large scale and on an urgent time schedule. *(Note — the Euratom group is made up of Belgium, France, Germany, Italy, Luxembourg and the Netherlands.)*

During the visit of the "Three Wise Men" in Washington last month a joint communique was issued by them, our State Department and Atomic Energy Commission in which it was stated:

"Examination of the Committee's program indicates that its objective is feasible."

In view of our Government's public statement, I am particularly desirous that nothing I say here tonight be interpreted as casting doubt on the feasibility of the Euratom program. But I do wish to point out that the communique's one sentence dealing with the question of feasibility did not mention some obvious assumptions. Among these, I might identify the following:

(1) The member nations of Euratom must be ready, willing and able to finance the program, which might cost on the order of 6 billion dollars by 1967.

(2) American and British industries must be willing and able to cooperate with industries and the governments of the Euratom nations.

(3) Euratom will establish promptly its Atomic Energy Commission — with adequate planning, coordinating, and administrative authority to carry out an agreed program.

I do not think we need to worry at this time about Euratom's ability to finance the atomic power program. The Euratom nations are now paying dearly for imported fuels and they will have to spend in the hundreds of millions of dollars annually for new conventional power plants if they do not build atomic ones. Therefore, Euratom's financial problem probably will be more concerned in the near future with the re-allocation of expenditures than in the raising of new revenues.

It goes without saying that American and British industry will cooperate with industry in friendly foreign countries. There has been no hint from any source that either American or British industry would be expected to declare a moratorium on profits. Regardless of any profit incentive, industry will benefit by the two-way flow of technical information and from the opportunities to expand its lists of licensee affiliates and customers.

I am sure you will be interested in some of the problems that Euratom must solve in carrying out its atomic power programs.

The Euratom program admittedly is an ambitious one. Its size and cost can be judged by comparison with the new British atomic power program. Whereas the British have set a goal of 5,000 to 6,000 megawatts of atomic power by the end of 1965, the Euratom goal is 15,000 megawatts by the end of 1967.

It is logical to assume that Euratom will adopt a policy of rapidly building up the technical know-how and the manufacturing capacities of its members so that their imports will be held to a minimum. To acquire the necessary technical know-how and to save time in actually getting into the business of manufacturing power reactors, it will be necessary to develop licensing arrangements with American and British reactor builders. I believe that such licensing arrangements can and will be worked out and that they will be mutually advantageous.

I do not think that Euratom will find it either desirable or possible to standardize initially on only one type of reactor. Speaking only for myself and *not* for the Atomic Energy Commission, I would expect Euratom to place orders for several reactor types with the idea that these would be imported in their entirety, erected and operated as soon as possible as prototypes for the training of Euratom engineers. Incidentally, the most serious handicap for Euratom to overcome is the shortage of engineering talent with experience in the many special aspects of the building and operation of reactors.

There are possibilities for standardization in the reactor components, fuel cycles and steam conditions of the reactors installed in the early years of the Euratom program. The advantages derived would be important in time savings, but, to be effective, a standardization program would have to be defined and adopted by European industry.

It is reasonable to assume that industry will want assurances from Euratom with respect to third party product liability. I understand that a precedent for limiting liability has been established in respect to international airplane travel. Also, some uncertainties about patent rights need to be cleared up.

Earlier I expressed my personal belief that Euratom initially might select several prototype reactors, but I did not mean to imply that Euratom's purchases of reactors would be limited to only those prototypes. On the contrary, I believe that if Euratom is to approximate its schedule for installations in 1963 and 1964, it will be necessary to buy as many reactors as can be manufactured short of an expensive crash program in this country.

Since Euratom will have only limited supra-national authority, its atomic power program will be achieved by six separate national programs which, however, will be coordinated by its Atomic Energy Commission. Euratom's biggest leverage will come from its ownership and effective control of all nuclear fuels used by the six member nations and by joint training and research efforts and possibly by joint ownership of such facilities as chemical reprocessing plants. I, for one, am confident that in the broader sense of the word — feasibility — the Euratom program is feasible, but it will require a tremendous, coordinated effort by the six nations to achieve 15,000 megawatts of installed atomic electric power by 1967.

Expansion Program

You will recall that when the Atomic Energy Commission undertook its big expansion program a few years ago, we were fortunate in having all the money we needed and all the authority required to get the job done on schedule. At one time, we were spending over 100 million dollars a month; we had approximately 15,000 architects, engineers, and technicians working directly or indirectly on our program; our construction labor force reached a peak of 74,000; our construction efforts represented about 5 percent of total construction in the United States, and we took approximately half of the entire American output of stainless steel piping. I am confident that we would not have completed our expansion program on schedule had the authority for its planning and execution been divided between different Government agencies. For this reason, I earnestly hope that Euratom will encounter no delays or difficulties in setting up its Atomic Energy Commission and other planning and administrative organizations to effectively coordinate the separate construction programs to be undertaken by the six member nations.

Elsewhere in Europe there is nothing to report as ambitious and spectacular as the Euratom plan. It is true, of course, that Austria, Denmark, Greece, Norway, Portugal, Spain, Sweden, and Switzerland have atomic energy programs in varying stages of development. Up to now, these programs have been devoted largely to research, but government and industry in all of these countries are now actively studying the possibilities for atomic power. Norway is particularly interested in the possibilities of atomic power for merchant ship propulsion. In Sweden, a 95,000 kilowatt reactor is being installed in a suburb of Stockholm to supply heating for a large housing development. Five additional reactors for central district heating are also planned.

Naturally, there is little to say about what is going on in the field of atomic power behind the Iron Curtain. There has been an announcement that Czechoslovakia will begin the construction of a 150,000 kilowatt atomic power plant during the current year and that other plants are planned for completion after 1960. East Germany also has indicated its expectations of starting construction of a 150,000 kilowatt atomic power plant this year. In the Soviet Union, the announced program calling for installation of 2,500 megawatts of atomic power by 1960 appears to be slipping as indicated by recent Russian statements that speak of commencing three of their five large projects in 1958, 1959 and 1960. It is interesting to note that the Soviets are reported to be experimenting with seven different reactor concepts and are not wedded to any single reactor design.

There have been no announcements of plans for large scale atomic power plants in Latin America but such plans are likely to develop within a few years in the Argentine, in Uruguay and other countries where indigenous fuels are lacking and where there are large cities and industries. Two atomic power plants of 10,000 kilowatt capacity are being manufactured in the United States for installation in Brazil and Cuba. Conditional contracts have been given to American firms for the construction of small atomic power plants for installation in Mexico and the Dominican Republic.

Negotiations have been in progress for some time for a 60,000 kilowatt atomic power plant in Manila and recently a contingent order has been placed with an American manufacturer for a 15,000 kilowatt atomic power plant on Taiwan. Two of the largest public utility companies in Japan are in active negotiation with American manufacturers for the installation of atomic power plants of the order of 150,000 kilowatts each. The Japanese Government has sent survey teams to the United States and to England and a few weeks ago announced that new survey teams would be sent to make further studies. Meanwhile, Japan appears to be waiting for the International Atomic Energy Agency to come into existence before proceeding with further negotiations with this country and England for agreements for cooperation in the field of atomic power. However, I am convinced that Japan, like England and the Euratom nations, will find atomic power economically and politically feasible some time before atomic power becomes economically competitive with conventional thermal power in most parts of the United States.

Mr. Etzel also stressed the impor-ance of being assured of an adequate and continuing supply of atomic fuels, both enriched uranium and natural uranium. His concern is understand-ible, for in the minds of foreigners he availability of nuclear materials pparently is the biggest unknown actor in the atomic power problem. However, let me remind you that President Eisenhower, in his Feb-uary 22, 1956, announcement mak-ig available 40,000 kilograms of ur-nium 235 for distribution, half do-nestically and half abroad, said that: ". . . the Atomic Energy Com-nission has informed me that it will ecommend that additional supplies e made available as becomes neces-iry in the future." Also, the joint ommunique issued last month in Washington by the State Depart-ent, the Atomic Energy Commis-on and the Three Wise Men stated at: ". . . Under present circum-ances, the availability of nuclear els is not considered to be a limit-g factor."

Obviously, this Government can-ot make at this time a firm commit-ent to Euratom as to the availabil-of specific amounts of atomic els. First, the Euratom treaty must ratified by the parliaments of the member nations. Next, a treaty an agreement for cooperation be-een Euratom and our Government ust be concluded. But in the mean-ne we can make firm commitments th respect to adequate fuels to individual member nations of ratom under bilateral agreements cooperation to meet their interim eds. We are now negotiating such nmitments and agreements with ance, Germany, and Italy and we e already concluded agreements h Belgium and the Netherlands the field of atomic power. Since can now give adequate assurances h respect to the availability of atomic fuels to the member nations of Euratom through our bilateral agreements, these countries can start construction of atomic power plants without necessarily waiting for the conclusion of a treaty or an agreement between Euratom and our Government. Therefore, I do not believe that the Euratom atomic power program need be delayed because of the absence at this time of a firm commitment directly to Euratom.

Delaying Elements

I should like to discuss very briefly two aspects of atomic power that presently are delaying its progress. I refer to the higher capital costs for atomic power plants than for conventional thermal power plants and to the estimated higher operating costs in most localities around the world. Undoubtedly, these cost differentials will gradually disappear as the result of:

(a) technological improvements in exisiting reactor designs, including particularly the fuel elements and the chemical recycling processes for spent fuel elements; and *(b)* the development of new reactor concepts; and *(c)* the perfecting of methods to burn up the by-product plutonium, and *(d)* possible future increases in the costs of coal and oil.

There are, however, several steps that our Government might take to reduce the present cost differentials between atomic and conventional thermal power plants. The Atomic Energy Commission has announced several measures that have been adopted to encourage private industry to build and operate reactors in this country. We now have under very active study a number of proposals designed to augment our foreign Atoms for Peace Program by accelerating the installation of atomic power plants in friendly foreign countries. Among other things, these proposals would extend to atomic power projects abroad some of the same kind of research and development assistance available to similar projects in the United States. One of the proposals deals with the method of our distribution of atomic fuels outside the United States. The Atomic Energy Act of 1954 provides that only our Government may own atomic fuels in this country. Consequently, the Commission leases atomic fuels for use in reactors within our borders, and, to assist the pioneers in the atomic power field, we have offered to waive the use charges for reactor fuels for the first five years of the active life of reactors built under our Power Demonstration Program.

The same law provides that the Commission may "distribute" atomic fuels abroad only pursuant to agreements for cooperation which provides, among other things, that the cooperating nations must guarantee that any nuclear materials transferred pursuant to such agreements will not be used for atomic weapons, or for research on or development of atomic weapons, or for any other military purpose. There is nothing specific in the law that forbids the Commission to lease atomic fuels to foreign governments under agreements for cooperation.

Costs of Fuel

The difference in method of distribution, that is, whether by sale or by lease, could make a very significant difference in the initial capital requirements for an atomic power plant as well as a difference in the operating costs throughout the useful life of the reactor. For example, a typical atomic power plant of American design costing in the order of 35 million dollars might require about 20 million dollars worth of slightly enriched fuel to charge the reactor and keep the supply pipelines filled between the reactor and the plants where the fuel elements are made and reprocessed. The difference is appreciable between capitalizing the fuel inventory costs and leasing the fuel inventory at 4 per cent per annum, which is the rate charged for the use of atomic fuels in reactors in the United States. A privately-owned utility company in a foreign country might prefer to lease atomic fuel on these terms whereas a foreign government, for political, but non-military, reasons, might prefer to buy and own the atomic fuels.

In the Commission's consideration of this problem, we must look ahead to the difficulties we might encounter at some future time if we should now embark on a course of leasing atomic fuels for large foreign programs. To get an idea of the magnitude of this problem, let us assume that the Atomic Energy Commission would agree to provide half of the atomic fuel required for the Euratom program up to 1967, by which time 15,000 megawatts of electric power is planned for installation. If we further assume that all of the fuel to be supplied by us is slightly enriched uranium suitable for use in American-designed reactors, the value of the inventory in the reactors and in the supply pipelines that we would have out on lease by 1967 might be of the order of one billion dollars. I cannot predict the course of action that the Commission will take, but I am confident that an equitable and effective solution to this complex problem will be found in the near future by our Government.

In conclusion, I wish to say something about what is happening in the field of atomic power in the United States. I assume that most of you in this audience have been participating in the discussions here in Philadelphia during the past three days, and you will have heard many reports from American industrial leaders and from engineers and scientists concerning developments in this country. I shall attempt only to summarize the situation as I see it.

Including the boiling water reactor which formally began operations at the Argonne Laboratory on February 9, there will be five and perhaps six reactors delivering electrical power in the United States before the current calendar year is ended. The largest of these will be the pressurized water reactor at Shippingport with a capacity of 60 to 100,000 electric kilowatts — the world's first atomic power plant devoted entirely to serve civilian needs. The other atomic power plants to be completed this year are the sodium reactor at Santa Susana, California, the boiling water prototype power plant at Vallecitos, California, and the Army package power plant at Fort Belvoir, Virginia, which will be delivering electricity into the Post's power system within a few months. Also, the homogeneous reactor at Oak Ridge may come into operation this year and supply electric power to the great laboratory complex.

According to industry's own published reports, our atomic energy industry in 1956 began construction or received contracts on a total of 59 new atomic reactors, including 29 power reactors and 30 research and test reactors. The research and test reactors will be built for private U.S. buyers, for the Government, and for overseas export. The power reactors are designed for various needs as, for example, naval and merchant ship propulsion, for prototype and demonstration reactors for the Atomic Energy Commission and for land-based power demonstration plants for private purchasers.

By the end of 1962 the Atomic Energy Commission expects that there will have been completed at least 18 civilian atomic power plants including one with a capacity of 180,000 kilowatts which will be similar in design concept to the boiling water reactor now in operation at the Argonne National Laboratory.

Despite the fact that power costs in the United States are far below the cost levels in most other parts of the world, I am confident that atomic power projects to be completed will increase in number and size from year to year during the 1960's. We will have the advantage by then of the development and testing of the ten reactor concepts that the Commission is now supporting. Also our civilian program will continue to benefit from our tremendous naval propulsion program.

With the sound technological base that we have built, with the vast experience that we are acquiring, with our great engineering talent, and with our unsurpassed industrial capacity there are no sound reasons for misgivings as to the standing of our civilian atomic power program a few years hence. Let me remind you that no other nation has offered to make available atomic fuels for power projects as this country has done. No other nation, so far as I know, has received export orders for research approaching in numbers those now being manufactured in the United States for foreign customers. No other country, so far as I know, has actually received firm orders for power reactors of the size now being manufactured in this country for installation in Latin America. And so far as I know, no manufacturers in any country are as close as those in the United States to the signing of firm contracts for large scale atomic power plants for export. I am certain that no other nation matches our experience and know-how in the designing, building and operation of reactors for ships.

I do not say these things boastfully, for I believe that there should be atomic power plant business for both American manufacturers and their competitors overseas. We only want to be in a position to win our fair share of the world's markets on merit.

Remote Handling Facilities (cont. from p. 1133)

using the appropriate values of μ and K which are found in the literature [4, 5, 6, 7, 8]. The value of B for 3.3 density glass has not been determined for other than Co^{60} radiation. Generally speaking, however, the build-up factor increases as the energy of the gamma ray decreases, but for these calculations it has been assumed that the variation is not great over the energy range of interest. Hence B has been kept constant. The results of the calculations are given in Table V.

Fields and Youngquist[9] have stated that an Argonne cell, which has similar shielding walls, is capable of handling 100 curie amounts of 1 Mev. radiation, in reasonable agreement with the above results.

Although the cell is rated at only 70 curies of 1 Mev. gamma radiation, it is possible, by judicious use of personnel, to handle much larger amounts of activity and still have no overexposure. The cell has handled sections of NRX rods which were irradiated to several hundred MWD/tonne, and regularly handles small sections of experimental fuel elements weighing several hundred grams which have been irradiated to several thousand MWD/tonne. The most active source which has been handled was rated at 4,000 curies of Co^{60}

Summary

The remote control handling cell in the metallurgy building at Chalk River, Ontario has been in active operation since October 1955. Although there are some features of the design which could be improved the cell has proved to be a very valuable facility for the examination of radioactive materials.

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Papers from the 1957 Nuclear Congress

(Held in Philadelphia, Pa., 11-15 March, 1957)

The proceedings of the Congress included the 2nd Nuclear Engineering and Science Conference; 5th Atomic Energy in Industry Conference; 5th Hot Laboratories and Equipment Conference; and 3rd International Atomic Exposition. E.I.C. was a sponsor.

The papers in this list are available in separate copy form until January 15, 1958. Nuclear Engineering and Science Conference papers are priced at 30¢ each. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N.Y.

(See also notice on page 1128)

Coolants

7—NESC-76. Gas coolant for nuclear reactors; by Michael Silverberg.

7—NESC-80. Use of boiling water as a reactor coolant; by S. Untermeyer.

7—NESC-104. UO_2—NaK slurry studied n loops at 600 C.; by H. E. Flotow, R. D. Carlson, and B. M. Abraham.

7—NESC-113. Heat transfer considerations in the use of organic reactor coolants; by T. T. Shimazaki and W. F. Anderson.

7—NESC-115. Design and development f the coolant system for the sodium reactor experiment; by D. T. Eggen, A. M. Stelle, and M. Heisler.

Educational Use of Reactors

7—NESC-73. Educational uses of the mall 5-watt laboratory reactor; by John V. Flora.

7—NESC-74. Reactor experiments in Oront; by Herbert Pomerance.

7—NESC-75. The Argonaut reactor; by . H. Armstrong, C. N. Kelber, D. H. Lenox, and B. I. Spinrad.

7—NESC-85. The water boiler as an instructional tool; by Clifford K. Beck.

7—NESC-105. Educational uses of the ickle-barrel; by Richard Stephenson.

7—NESC-110. A portable, polyethylene-moderated, training and research reactor he AGN 201); by Arthur T. Biehl, Richrd A. Fayram, Marion M. Harvey, Gusve A. Linenberger, John D. Randall, and Martin C. Reder.

—NESC-112. The thermal test reactor nd its applications; by H. B. Stewart, B. Gavin, and R. E. Slovacek.

Fuel-Cycle, Economics, Production, and Recovery

—NESC-22. Reactor design and the fuel cycle; by Robert B. Spooner.

57—NESC-23. Conceptual design of remote fabrication plant; by Joseph Koslov and Conrad M. Ladd.

57—NESC-26. Conceptual design of pyrometallurgical reprocessing plant; by Louis Basel and Joseph Koslov.

57—NESC-27. Liquid metal fuel reactor (LMFR); by C. J. Raseman, H. Susskind, and C. H. Waide.

57—NESC-41. Fuel cycles in single-region thermal reactors; by Manson Benedict and Thomas H. Pigford.

57—NESC-42. The fuel cycle from the standpoint of the fuel reprocessor; by C. E. Stevenson.

57—NESC-45. Pilot-plant studies on non-aqueous leaching of western ores; D. D. Foley, W. A. Meeley, and R. B. Filbert, Jr.

57—NESC-46. Uranium recovery at the Oak Ridge gaseous diffusion plant; by R. J. Clouse, J. Dykstra, and B. H. Thompson.

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(*See also notice on page* 1128)

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

BATHYTHERMOMETER TELEMETERS OCEAN DATA

J. M. Snodgrass and J. H. Cowley Jr.—*Electronics*, May 1957, vol. 30 no. 5

Ocean temperature as a function of depth provides valuable information for oceanographic studies. Previous methods of measurement by mechanical means provided an accuracy of ±0.5C and ±5 ft. in depth. Resolution of the order of 1 ft. in 1000 in depth and 0.1C in temperature are required today in oceanographic work.

An instrument has been designed and is in use which employs the frequency variation of a thermistor Wien-bridge oscillator to measure temperature and the frequency change of a vibrating wire connected to a flexible diaphragm provides depth information. Both signals are sent over a single conductor to the ship where they are separated by high pass and low pass filters for recording.

The depth measurement device using a Vibraton is a vibrating wire transducer in which a mechanical displacement is converted into a frequency change of a vibrating wire. The wire is connected at one end to a pressure sensing diaphragm. A displacement of the diaphragm changes the tension in the wire thus changing the frequency of vibration. The wire is of non-magnetic material and is placed in a fixed magnetic field at right angles to the axis of the wire. When the wire vibrates at its natural frequency it becomes an a-c generator, generating a voltage that can be amplified by conventional means. If some of the amplified voltage is fed back to the ends of the wire in phase with the generated voltage, vibration is sustained. The amplitude of vibration is controlled and the output frequency is a pure sine wave, regulated by the axial displacement of the wire, and it is nearly a linear function of the pressure applied to the pressure sensing diaphragm. The temperature stability of the amplifier was tested from 5 to 55C and was found to be adequate.

Water temperature is sensed by an oscillator of the Wien bridge type with thermistors in the reactive arms of the bridge. The temperature stability of the oscillator was found to be satisfactory in that when properly adjusted, there was a frequency variation of only one to two cps over an 8-hour period at constant temperature. Speed of response is important since the instrument is lowered and raised through the water at a rate of 2.5 fps. A thermal time constant of one second or less is necessary to resolve all the detail present which has been obtained upon occasion by grinding down the glass surface of the thermistor beads.

Both units are housed in silica-filled epoxy resin capsules. They have been used at sea with good results. The resulting resolution of the overall depth measuring system is of the order of 0.3 inch. Absolute accuracy in depth is better than ±0.25 per cent or ±2.5 ft. in 1000. The temperature sensitivity is approximately 40 cps per degree C. When these parameters are converted to dc and applied to the function plotter with a ten-inch chart width, a depth variation of ±2.5 ft. per 1000 can easily be read. If ten degrees of temperature are applied to ten inches of chart, a temperature variation of 0.05C can be accurately plotted. Reproduction of pressure and temperature plots have been accurately checked and found to take place without significant hysteresis effects.

ULTRASONIC CLEANING OF PRECISION GEAR REDUCERS

Machinery, May 1957 v. 63 n. 9

The production of precision components requires exact manufacturing methods very often including thorough cleaning operations. Small scale assemblies such as instrument speed reducers contain gears, miniature bearings and many other precision parts. In this particular case specifications required that the backlash in each reducer be less than 6 minutes of arc when measured with test loads of 1 inch-ounce. The assemblies needed to be thoroughly cleaned before testing since even the smallest particle of dirt could cause the driving torque to exceed this value.

Previously, the cleaning was performed by spraying with a solvent under pressure but this proved to be a slow and unreliable method. Dirt and other foreign particles inside bearings, in tapped holes and in other inaccessible places often could not be removed. This frequently resulted in excessive rejects, faulty operation or excessive wear. By utilizing ultrasonic cleaning methods these problems have been overcome with less time involved and with improved performance of the product.

The equipment used consists of a generator which supplies electrical energy to a transducer which acts as a container holding a fluid solvent. The transducer converts electrical energy into mechanical vibration which in turn produces cavitation in the cleaning fluid. This cavitation causes a violent scrubbing action which can remove dirt and other foreign matter from places otherwise inaccessible. Performance of the device is closely linked with the magnetostructive material used in the transducer. For durable construction nickel and certain nickel-iron alloys are generally selected. With these metals transducer efficiency can be as high as 90 per cent and the size and shape of the device can be designed to suit the application. For most cases a laminated type of construction gives the best combination of low losses and high capacity. The size is determined by the volume of fluid needed for cleaning and the shape by the operating frequency. The equipment is rated in terms of both frequency and power. Most units on the market range in frequency from 20,000 to 50,000 cycles per second and in power from less than 100 to several hundred watts.

FATIGUE, CREEP AND RELAXATION IN METALS

G. R. Gohn, *Bell Laboratories Record*, v. 35, No. 6, June, 1957

The principal causes of failure of metallic parts are corrosion, wear, fatigue and creep. Corrosion depends primarily on the chemical constituents of the materials and the environment. Wear is a problem which can be modified by machine design and lubrication. Fatigue is the behaviour of a material under repetitive stress and is the decisive factor in the life of many machines. It causes more than 80 per cent of the failures in machine elements. Creep is the behaviour of a material under continuous load. While it is important at room temperature only in special applications, creep becomes more decisive as the operating temperature or load increases. One result of creep, called relaxation, is of interest to the telephone industry.

Repeated stresses in metals cause fatigue. Such stresses exist in springs, diaphragms, rotating shafts, structures that are alternately loaded and unloaded, and in apparatus subjected to shock or thermal changes. Recently the work of physical metallurgists and research statisticians offers what appears to be a plausible explanation of fatigue. Fatigue can usually be associated with the progressive strain-hardening of the material, particularly in areas of high stress concentrations. This process is familiar to anyone who has repeatedly bent or stressed a piece of metal and found that it offered more and more resistance as the bending continued. When repeated stress is applied to a part such as an automobile axle, stress is concentrated in certain areas rather than being evenly distributed. This may lead to overstressing in some areas, starting a small crack. The corresponding reduction in area produces higher stresses and under repeated stressing the crack increases progressively to the point where the cross-section of the part can no longer carry the load. Sudden failure then occurs without advance warning. The failure is usually characterized by a non - ductile, crystalline - appearing fracture in which the failure path ignores crystal boundaries. This type of fracture is the means by which fatigue failures of most metals, except lead, can be identified upon detailed metallographic examination.

While this reasoning can explain many fatigue failures, it has been observed that certain cold-worked materials such as copper, lead alloys and aluminum, soften to a degree during cyclic stressing and that areas of low hardness develop at or near the point of failure. The strain-hardening theory does not adequately explain this phenomenon which may be associated with recrystallization or thermal effects.

The precise fatigue properties of a metal required for engineering design must usually be determined by laboratory tests made on carefully machined specimens. Tests were made on a 5 per cent tin bronze a material commonly used in the manufacture of telephone apparatus springs. At high stresses but at values well below the tensile strength, and usually below the proportional limit failure occured after only a relatively few cycles. However, at lower stresses, a point is reached at which no failure occurs even after an almost infinite number of cycles. Today, for a 40 year life, one billion cycles represents a desirable end point. Changing the spring material to nickel silver or phosphor bronze has resulted in longer life than for brass since they have a higher fatigue strength. Voids and inclusions of non-metallic particles have been reduced through better manufacturing processes and better material specifications thus eliminating many factors that increase localized stresses. This has been supplemented by producing finer grained materials, by elimination of stress-raisers such as tool marks or die stampings in highly stressed areas, by more careful adjustment of springs in the field to avoid nicking and by designing the springs within safe stress limits.

Fatigue failures in open-wire lines have been caused by vibrations set up by winds or road shocks. The damage is done mainly by vibration around 30 c.p.s. This frequency of vibration also can cause fatigue failure in lead cable sheathing. (The frequency is not encountered in th

NEW STRUTTED ROOF CONSTRUCTION

A patented triangular type of roof construction, patterned after the Hess-Grafrath system, has been introduced by a firm in Munich, Germany (Dreieck-Streben-Bau-Auswertung). The system, referred to as DSB, is said to save over half the wood requirements in roof construction. The DSB beam consists of an upper and lower flanged plank, joined by a strutted system attached by a suitable adhesive. The shear strength of the glued joints is at least that of the adjoining grain. The phenolic resin-based glue does not need application of pressure for setting.

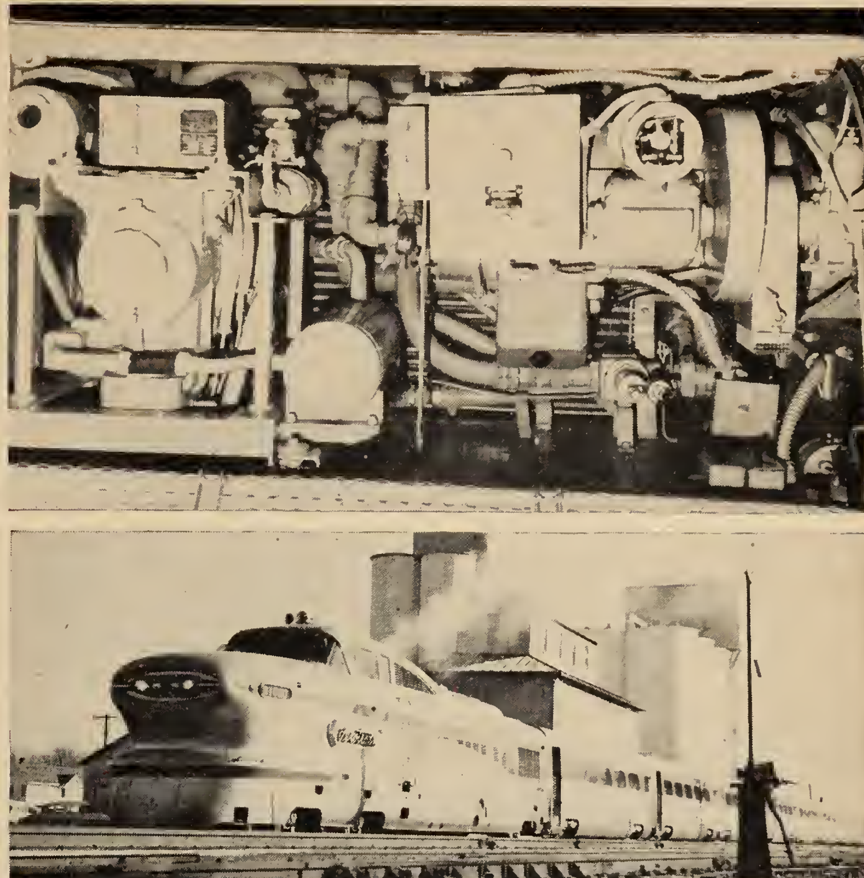
field installations but in transporting reeled cable on railway freight cars with slightly flattened wheels.) Also, the extremely slow cyclic stress changes which occur in aerial cable as a result of daily and seasonal temperature changes can cause failure.

Whereas fatigue occurs because of repeated stresses, creep results from continuously applied unchanging loads. It is defined as the permanent extension of a material under constant load. Except for lead and lead alloys, creep of significant magnitude seldom takes place in metals at room temperatures. Creep occurs as a result of viscous flow in the grain boundaries, of "slip" along crystallographic planes, and of rotation of the grains. Any one set of these mechanisms may predominate but all contribute to the total effect.

Creep problems occurred in the lead cable sleeves used to protect splices in toll cables which were gas pressurized to protect against moisture penetration. Internal pressure produced a constant stress in the sleeve material.

Fatigue and creep properties of a material can be improved by alloying, by cold working or by heat treatment. Of these the most effective is alloying. Fatigue resistant properties are improved by using finer-grained materials, while creep resistance is improved by using coarser-grained materials. Where both fatigue and creep are factors in the service life of apparatus, a compromise must be effected. Where both constant and repeated stresses are superimposed he creep rate will be accelerated by atigue failure and the life of the part is generally shortened.

Relaxation, which is a possible result of creep is the loss of stress in structural member held at constant ength; e.g., loss of tension in the taybolt of a boiler or in a stud holding a cover plate. Loss of stress occurs rapidly for a short time then becomes slower until a stress level s reached at which further change is ery small. Except in the boiler and urbine fields relaxation has played o small a part in deterioration processes that little investigation has been one in this area. During the development of solderless, wrapped ire connections studies of relaxation in copper switchboard wire were arried out at the Bell Telephone aboratories to insure that relaxation henomena would not adversely affect the reliability of the connections.



LIGHTWEIGHT TRAIN VISITS CANADA

Seen in Canada for the first time recently was the lightweight train developed by the Electro-Motive Division of General Motors, in La Grange, Ill., as the result of discussions with American railroad officials. The train (seen above) was developed as an experimental unit of engine and ten 40-passenger coaches. Two trains were built and were intensively tested (including the use of a closed television circuit to follow wheel tracking) before being operated on revenue service by three American railroads for several months. It is claimed that the coaches could be mass-produced for about $1000 a seat, compared with current cost for conventional equipment of over $2000 a seat; the centre of gravity is considerably lower than normal; weight is very much reduced; and operating costs should also be much less than with an ordinary diesel-hauled train. The engine of the "Aerotrain" is powered by a single 1200-h.p. diesel engine and drive is via two electric traction motors operating on the front four-wheel truck; the rear of the engine is supported on a two-wheel idler truck. Each coach has only two two-wheel trucks; suspension is by air bellows (similar to that used on some buses) and is compensated to give a level ride on banked curves. Coupling the coaches automatically connects all services. Each coach also has its individual air-conditioning unit (top picture) located, together with heating units and space for heavy baggage, below the coach floor. Power for these services is supplied from a 440 v., 3-phase, 60-cycle auxiliary generator in the engine. Design maximum speed is 102 m.p.h.

CENTRIFUGAL BOILER COMPRESSION STILL

K. C. D. Hickman, *Industrial and Engineering Chemistry*, v. 49, No. 5, 1957

Methods for desalinification of salt water are being investigated under the sponsorship of the U.S. Department of the Interior. A compression still has been devised which contains a rapidly rotating evaporator-condenser of sheet metal. Under centrifugal force the liquid films on both sides of the rotor are maintained so thin that overall heat transfer coefficients of U = 2500 to 6000 B.t.u./ft., hr., °F. are developed. Many tons of sea water have been distilled from a pair of copper cones 18 in. in diameter, without development of scale and without the heat transfer coefficient changing from an initial U = 3600. A temperature differential as low as 3° F. has been reallized. Experiments have been extended successfully with disks 4 x 5 ft. in dia. and the performance extrapolated to larger sizes. So successful were the tests that a still with 8 ft. rotors has been constructed.

The more significant parameters of

this kind of still have been measured and are recorded in this article. It appears that the relative area of evaporator-condenser surface can be diminished by a factor of 5 to 10 times and the total power requirement of a water-producing installation, given suitable ancillary equipment, can be reduced to less than 5 watt-hours per pound of distillate, or about 42 kwh. per 1000 gallons (U.S.) of fresh water distilled from sea water. This is about 17 times greater than the absolute, "second low" minimum postulated in a previous article, but less than half the power requirements of existing compression stills if they are operated at an acceptable ratio of output to first cost.

ADVANCED CONCEPTS ON THE PROPAGATION OF ELECTROMAGNETIC WAVES

W. T. T. Reikie, M.E.I.C.

The classical approach to the problem of electromagnetic wave propagation has relied heavily on the theory of light. Huygens in the enunciation of his principle concerning the reradiation of a wave front, qualitatively established light as a phenomenon of wave motion. Fresnel in the development of his integrals placed the theory of light on a quantitative basis which in the form of the Cornu spiral became a practical theory.

Fresnel's development of a theory backed by experimental evidence required the acceptance of a principle that has been aptly referred to as the fortuitous law of obliquity and attempt is herewith made to track down the true nature of this law.

Visualize the optical path belonging to a source and receiver consisting of the intervening space zoned into Fresnel zones of increasing order. Also recall the following dominant characteristics of such an optical path, namely the fixed volume of each zone is given by the volume of the initial or polar ellipsoid, and the fixed half wavelength path increment between adjacent zones.

Working upon the basis that a frozen wavefront position cannot be held responsible for the complex signal delivered to the receiver it is of interest to observe that a reradiating wave-front essentially carries its reradiation products along with itself while at the same time obeying the inverse square law which dictates the conservation of wavefront energy. Thus the wavefront from which a sample signal is extracted by the receiver contains in the complex nature of this signal none other than an historical record of the effective reradiation products cumulatively stamped upon itself in travelling through the entire distance from source to receiver.

Postulating that effective reradiation products within any given Fresnel zone originate from those reradiating elements which possess angles of break or obliquities which are not present within higher zones concentrates attention upon a very interesting feature; namely, that reradiating elements satisfying the above conditions are confined to symmetrically disposed mid-path volume elements whose volume for any given zone is proportional to its radial depth. It is now only necessary to consider equal volume elements as supporting equal reradiation product amplitudes regardless of the location of such elements within the effective reradiating zones under discussion in order to ensure the arrival of a wavefront sample at the receiver permitting evaluation in accordance with standard Fresnel integral procedures.

Should we now choose to consider volumes satisfying similar conditions to those described above but selected for angles of break which are not present within the higher Fresnel zones after skipping one or two or more zones initially it will be found that for Fresnel zones sufficiently removed from the polar zone the resulting volumes are twice, thrice, etc., the size of the original volumes for which a zero skip applied. This would appear to indicate that the additional or flanking volumes are basically capable of supporting secondary reradiation products of similar strength to those contained in the original volume. However, detailed construction of individual Cornu spirals for the leading and lagging flanks of such volumes reveals a pair of spirals skewed in opposite directions due to progressive positive and negative increments of field strengths within these flanks as the summation approaches the polar zone (i.e., moving out from the anchored convergence point for such partial spirals of secondary reradiation products).

The above demonstration, that flanking zones support spirals of reradiation skewed relative to the effective spiral of reradiation, coupled with the knowledge that these reradiation products of the wavefront must accumulate in accordance with the conservation of energy, can be tied together in the following manner; namely, all skewed spiral pairs must automatically wash out each other's reradiation products for the optical path to which they belong. Thus the true nature of the law of obliquity appears to be none other than a well-disguised form of the law of the conservation of energy as applied to the interlaced wavefront reradiation products belonging to an optical path.

In introducing the source of effective reradiation products our initial postulation concentrated attention upon symmetrically disposed mid-path volumes as the source of favoured reradiation products and this in turn elucidated the introduction of the concept of skewed spiral cancellation for flanking volumes. If now this latter characteristic of self-effacing skewed spiral pairs be considered as the meat of the matter it is possible to recast our initial concept into the form of a frozen mid-path wavefront which in turn may be translated optically to a frozen wavefront position clear of the mid-path location.

The ability to shift frozen wavefronts to any legitimately desired path location is of great convenience when studying obstructed optical paths requiring a concentration upon conditions at obstructed or shadowed locations within the path.

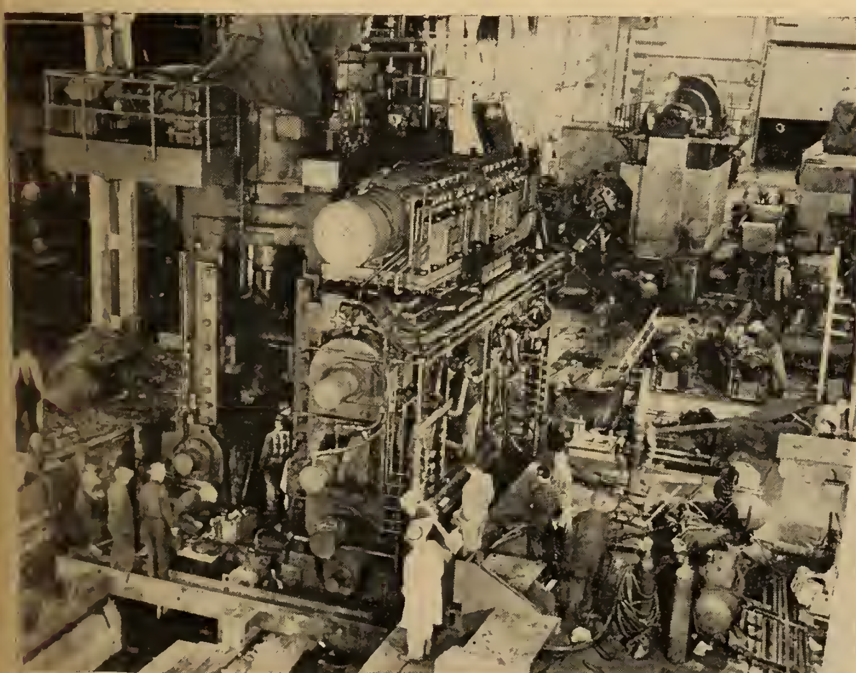
Once the logarithmic decay of resultant wavefront amplitude or strength due to the blotting out of polar Fresnel zones commences it is feasible to consider a knife edge obstruction as effectively blotting out three quarters of the wavefront in addition to the Fresnel zone count fully blanked by such an obstruction. The conversion of a knife edge obstruction to an equivalent iris obstruction has tremendous significance due to the realization that non - disturbed wavefront zones become absolutely necessary for the support of secondary illumination in the presence of knife-edge obstructions. Again, since a knife - edge obstruction ensures none other than the presence of non-disturbed wavefronts above the obstacle it now becomes feasible to reduce all obstacles, including smooth earth as an obstacle, to an equivalent knife-edge obstacle by simply locating the dividing line between non-disturbed and disturbed wavefronts above these obstacles. Such a procedure permits the use of a common language for diffraction problems.

The comprehensive discussion concerning secondary illumination characteristics in terms of light theory as given above requires the introduction of an additional concept in dealing with an optical path for an electromagnetic wavefront originating from a source and being accepted by a receiver possessing one degree of freedom rather than the two degrees of freedom present for a light source and receiver.

Briefly, the complex signal carried within the eye of the Cornu spiral permits evaluation in terms of a simple resultant only in the presence of universally polarized fields exciting a receiver of two degrees of freedom.

Thus an examination of the vector wrapped up within the eye of a Cornu spiral reveals the existence of a series of resultant signal vectors, angularly disposed in this eye, capable of capturing a one-degree freedom receiver excitation so as to delete receiver response in terms of any individual vector in this series. There remains, however, an excitation which in the presence of a tuned receiving circuit or antenna permits the development of a kick-back response. Through the introduction of thermodynamic principles it is possible to calculate that this kick-back response will reduce the simple resultant diffracted signal values.

The requirement for the support of secondary illumination by non-disturbed wavefronts thus is doubly necessary in dealing with propagation of energy at radio frequencies. Scatter theory must therefore be merely considered as an artifice for reintroducing path depth in treating secondary illumination effects due to a failure to realize that frozen wavefronts in themselves required the reference of these depth effects to a single wavefront.



UICK REPLACEMENT OF STEEL-MILL EQUIPMENT

an expansion program at the Hamilton plant of Dominion Foundries & Steel mited an old slabbing mill had to be removed and replaced with a new mill ie largest of its kind in Canada). Careful planning resulted in a down-time of ly 12 calendar days between shut-down of the old mill and running an ingot rough the new one. The new 650-ton, 46-in., 2-Hi slabbing mill was assembled temporary foundations 50 feet from the old mill, which continued to operate. rms for the new permanent foundations were prepared, complete with reinforcing el, ducts, etc., and new piping and electrical equipment installed. The old mill s shut down, dismantled and removed; old foundations blasted out; the new ms placed; and a quick-setting concrete poured. The new mill (above) was ved by a hydraulic jack on two specially lubricated steel rails to its permanent ndations. The work was carried out by the H. K. Ferguson Company.

FUELS: TODAY AND TOMORROW

Mechanical Engineering, June, 1957, v. 79, No. 6

In the United States the domestic market for bituminous coal has shifted radically under the competitive impacts of oil and gas, and as the result of ever-changing technology. Railroads which once consumed 20 per cent of the total coal production now operate with diesels and oil fuel. Residential and commercial use of coal has decreased; new homes tend to use gas, while old ones have switched to oil. The market that remains is subject in the long run to less competition from other fuels, and it is an expanding market.

The electric power industry has become the largest single coal customer. In 1955, 140 million tons were consumed by thermal electric plants, and it is likely that coal will retain its share (two-thirds) of this market, and the share could rise; 107 million tons of metallurgical grade coal were consumed by the coking industry, mostly for domestic steel. General industrial consumption exceeded 106 million tons, and exports amounted to 51 million. Electric power, steel and exports are considered to have excellent growth prospects and are characterized by a relatively stable demand for coal.

Coal prices have shown a long-run rise conforming to an increasing exponential trend averaging 1½ per cent annually since 1910 but this should be viewed in relation to the general inflationary trend. Productivity in underground mines is estimated (1955 data) at 1.1 tons per man-hour; in strip mines it is nearly three times as high. The average for the entire industry is 1.3 tons per man-hour, or over 10 tons per day per man. In mines using continuous mining equipment the output has been at least 4 tons per man-hour. It is expected that productivity will continue to grow through expansion, development, and improvement of continuous mining. About 23 million tons were produced with this equipment in 1955 against a total of 470 million tons. Geologically most continuous mining equipment requires coal seams at least 3½ ft. thick.

The rapid rise in hourly earnings in coal mining over the past ten years should ensure that miners will stick to mining rather than move to other industry. With new methods of shipping coal there has been a shift away from complete dependence on railroads; 79 per cent of all bituminous coal in 1953 was shipped from the mines by rail compared to 84 per cent in 1947. One transportation technique of the future involves a 50 per cent mixture of coal slurry and water in long-distance pipelines. Another prospect is long-distance conveyor belts. Barge traffic will continue to increase and the increasing combination of mine-mouth power generation with either long-distance transmission (as a result of improvements in power transmission techniques), or locational shifts of industry to nearby sites, can also yield savings in coal transportation costs.

The United States energy consumption in 1955 amounted to 40.7 x 10^{15} B.t.u. of which 28.4 per cent was supplied by coal, 41.3 per cent by crude petroleum and products, 26.8 per cent by natural gas, and 3.4 per cent by hydro. This consumption is expected to double by 1980.

The trend is toward the use of materials that require more energy per unit weight or volume for their production and fabrication. For example, aluminum, the consumption of which is rising faster than that of older metals, requires more energy than do many of the materials it is replacing, such as steel, copper, lumber, paper or cement. Synthetic building materials, plastics and fibres use far more energy than the natural materials, to fit them for the market. As a reflection of this upgrading process, the electric power industry, which has been doubling every 10 years, has recently increased its pace so that it is doubling every 8 years.

The fact that energy demand will grow does not mean that all fuels will share equally, though it is inconceivable that the competition from any one fuel will reverse the growth pattern of another. Before 1930 petroleum and gas supplied 31 per cent and coal 66 per cent of the nations' total energy requirements. Now the relation is reversed and oil and gas supply 67 per cent and coal only 29 per cent. But demand for all fuels continues at an increasing rate. Future problems of the petroleum and natural-gas industries will be those of providing supplies, rather than finding markets. Technological development will facilitate location of deposits, permit deeper drilling and reduce cost of transport. Eventually, synthetic liquid fuels and fuel gas manufactured from coal and shale will play significant roles.

In many nations where it is more economical to make large capital expenditures than pay the higher prices for coal and petroleum, development of atomic energy will proceed rapidly. In the United States, industry and government are committed to the expenditure of about $300 million for the construction of six major nuclear-power plants having a total capacity of 800,000 kw. The AEC and the Navy have large financial investment in the development of reactors for use in an 85,000-ton aircraft carrier, a cruiser and some submarines. When the conventional fuels are in too short supply or become too expensive, energy from the fission of uranium or thorium, or even fission of the atom, may supply much of the demand for heat and power.

Development in the harnessing of solar energy is proceeding. Novel applications such as the silicon solar battery and high temperature solar furnaces have been devised and serious research on possible larger scale operations is presently being studied.

SENSITIVE DETECTOR CRAYONS FOR PHOSGENE, HYDROGENE CYANIDE, CYANOGEN CHLORIDE, AND LEWISITE

B. Witten and A. Prostok, *Analytical Chemistry*, v. 29, No. 6

A simple means for detecting and semi - quantitatively estimating the amount of trace quantities of gases in the atmosphere or in an enclosed space is frequently desired. One of the easiest ways of doing this is to use detector crayons, which are made by mixing detector reagents with suitable inert fillers and binders, and forming the resulting mixture into crayons. These can be used to write on many surfaces such as paper, wood, painted surfaces, etc., to give sensitive marks which change colour in contact with the appropriate gas or liquid.

In many cases reagent systems are known which are capable of detecting the desired compound with the requisite sensitivity by a colour change. These systems may often be used as the detector reagents which are incorporated into crayons. Detector papers can also be used for various gases. However, crayons are usually much more stable than the paper in storage because of their much smaller surface area which reduces the tendency of the active ingredients to volatilize and/or oxidize.

One of several ways to manufacture the crayons is to mix the detector reagents with blanc fixe (precipitated barium sulphate) or other fillers, add a suitable amount of wax-in-water emulsion for a binder, form crayons by extrusion, moulding or casting and then dry the mixture. These crayons may suffer from decreased sensitivity, probably because the wax partially protects the active ingredients from the gases.

Another method is to take the above mixture and compress it to make a crayon in a manner similar to making tablets. The simplest method is to dissolve the active ingredients in a suitable solvent, absorb this solution into moulded plain white blackboard chalk crayons and then dry the chalk. By this method, however, it is hard to control the amount of absorption and such soaked crayons often deteriorate more rapidly in storage than other types. In many cases the detector reagents can be mixed with the usual commercial crayon ingredients and formed in the usual fashion.

The sensitivity of the crayon marks to a gas can be expressed as a $C \times T$ value where C is the concentration of the gas and T is the time necessary for the crayon mark to respond to concentration C. If the crayon marks are exposed to similar environments of air turbulence, temperature, humidity, etc., the length of time necessary to cause a colour change is, to a first approximation, inversely proportional to the concentration of the reactive gas. Thus the CT value is approximately constant and is a measure of the sensitivity of the crayon mark. Although their use is primarily qualitative CT values will give a rough estimate of concentration.

Recipes are given for preparation of crayons to determine the gases listed above. An extensive study of the specificity of and interference to these crayons has not been made. They appear to be fairly specific and not too susceptible to interference by other gases. However, high concentrations of chlorine will interfere with most of these tests. No attempt was made to find the optimum composition and proportions of ingredients in these crayons but these described here are sensitive, stable in storage and write well.

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

With the labour force on the entire seaway and power project at a new peak of some 17,000 during June, the tempo of construction was accelerating. The international power-house is expected to reach 90 per cent of completion by year-end. At Long Sault dam, work will continue throughout the winter. At Iroquois dam when Stage II is completed late this year and the Galop Island cofferdam breached, the dam will take control of the water level in Lake Ontario.

Progress by Ontario Hydro

Weather was generally favourable for construction work throughout June. The labour force was increased to a total of 4,900 persons.

On the power-house site a total of 635,000 cubic yards of concrete had been placed to the end of June. Concrete placing operations were in progress on No. 11 and No. 12 draught tubes. Operations were also proceeding putting concrete in the No. 3 ice sluice and for the headworks of No. 16 unit.

Structural steel for the power-house erection bay and administration building had been virtually all erected. The framework for the 300 ton gantry crane had been assembled and work had commenced on the erection of the headworks gantry crane.

With setting of 8 speedrings in various stages of completion, the speed ring for No. 9 unit was being installed. The first three headgates had been received and preparation was being made to install them.

Excellent progress was being made on all sections of Cornwall dike, with 65 per cent of the material placed into this permanent structure. Excavation for dike construction had been completed between the power-house and the Cornwall diversion canal closure structure. This had involved the crossing of the old channel of Cornwall canal. The dike will be completed during the current season.

Progress of Ontario Hydro's section of the power-house. Concrete placing can be seen in the foreground; in the background, speed ring and turbine casings; in the extreme background, structural steel for erection bay.

Heavy freight trains had been operating over the relocated Canadian National Railway line between Cardinal and Cornwall during June. Most of the final adjustments on the automatic equipment had been completed in preparation for the operation of fast passenger trains. Work was being concentrated on the new stations and was well advanced.

Paving was virtually completed on the highway diversion between Cornwall and Iroquois. Work was progressing favourably on the Highway No. 31 overpass at the C.N.R. relocated tracks north of Morrisburg.

At the St. Lawrence transformer station, work was being concentrated on the sections that will receive 230-kv. power next year. This sector will tie the power from the new source into the Ontario Hydro system. About 65 per cent of the work on the second stage had been completed.

Excavation had commenced on Canada Island and work was also starting on dredging in the Cardinal area. In other channel improvements contracts, Spencer Island pier had been completed and dredging had started upstream from Galop Island.

At Galop Island, excavation clean-up work was in progress in preparation for flooding the cut. More than half the excavation had been completed at Iroquois Point and a dredge had started to work on the upstream end of the contract. Good progress also was being made in excavating Point Three Points and construction of the perimeter dike.

The first stage of house moving was completed in Morrisburg with seventy - one houses moved. The house moving program will continue on a reduced scale for the remaining seven houses in this phase.

Steel erection for a large block in the shopping centre was completed and bricklaying was underway. Also completed in the Morrisburg area was the final installation of the water intake facilities. Construction of the thirty-six rental housing units was progressing favourably.

At Iroquois, demolition within the old town continued with demolition of the Anglican and the United Churches underway. In the new townsites of Ingleside and Long Sault, general clean-up and painting operations were in progress. In Ingleside the steel erection had been completed for the new separate school and the new shopping centre.

Progress by NYSPA

With work on the project continuing on schedule, concrete placement on all features exceeded 1,220,000 cubic yards at the end of June. Excavation exceeded 41.5 million cubic yards. Employment averaged 5,720 for the month. Five speedrings were installed, while two turbine runners and some generator equipment had been delivered.

Concrete placement on the American half of the power-house continued on schedule. Some 53,000 cubic yards were placed during the month, bringing the total to date to 639,000 cubic yards. Structural steel work for the service building, the river crossing towers and the 115-kv. switchyard was progressing rapidly. Placing of embankment at the forebay training wall continued.

At Long Sault dam, excavation, drilling and grouting in the stage II foundation area had continued at an accelerated pace. Concrete operations were started early in June and 31,000 cubic yards were placed during the month, bringing the total to date to 256,000 cubic yards.

At Iroquois dam, 20,000 cubic yards of concrete were placed during the month, bringing the total to date to 160,000 cubic yards. With 8 piers built on stage II, placing of concrete in the deck had been commenced.

At Massena intake, the required excavation for the stage II structure was completed and concrete placement was started. 17,000 cubic yards were placed during the month, bringing the total to date to 142,000 cubic yards. Construction of the dike adjacent to the intake structure was resumed.

Channel improvement work at Sparrowhawk Point, Toussaints Island, Point Three Points, Leishman's Point and at Ogden Island was progressing on schedule. The channel work was approximately 75 per cent completed. Topsoiling and seeding at Galop south channel spoil areas were resumed. Construction of Richards Landing dike was started. The main dike was 85 per cent completed.

Clearing of the reservoir by the three reservoir contractors continued on schedule with approximately 6,700 acres or 56 per cent of the area cleared to date. The contract was awarded for park and woodland improvement between Barnhart Island power plant and Long Sault dam. Clearing and chemical treatment of the Barnhart-Plattsburgh transmission line right of way were completed.

Work under the three highway relocation contracts were progressing ahead of schedule. All phases of construction operations were in progress. The groundbreaking ceremonies June 14 for Reynolds Metals Company and Chevrolet Motor Division gave evidence of the forthcoming north country development.

Progress by SLSDC

With concrete placement at Eisenhower and Grasse River locks at over 60 per cent completion as of the end of June, final completion is expected by year's end. Some 9 million cubic yards had been removed from the mainland portion of the Long Sault channel out of a total of 13 million cubic yards, representing 70 per cent of completion.

Dredging of the south Cornwall channel was commenced in May on section A and continued on section C. In spite of a late start on this dredging, the required completion to 14 ft. depth by the time the headpond is raised in July 1958 is feasible, at which time navigation through the old 14-ft. canals on the Canadian side will be discontinued.

Progress by SLSA

According to an engineering progress report issued by the St. Lawrence Seaway Authority at the end of June, on the third anniversary of establishment of the Authority, progress was assuming a more rapid pace and work was well advanced. Dry excavation stood at 63 per cent of completion with more than 35 million cubic yards of rock, earth and other materials dug from the stream side to prepare the seaway channel.

A great fleet of dredges had removed from the riverbed no less than 7½ million yards of rock, sand, silt and other overburden for a progress figure of 41 per cent. Placing

The October, 1957, issue of the *Journal* will be a Seaway issue. This will mark the second time a complete technical section will be devoted to this important project, the earlier one being September 1956.

of concrete, which had, of necessity to await excavation, stood at 36 per cent of completion with 725,000 cubic yards placed to date, or 1½ million tons. Some 5,400 men were at work on the 90 general contracts awarded for construction and supply at a value of $230 million.

In the Lachine section, on 47 contracts valued at close to $100 million, 2,724 men were at work and completion had reached 45 per cent. In the Soulanges section on contracts valued at $38 million, 1,242 men were at work and completion had reached 25 per cent. A further 330 men at Lake St. Francis had reached 75 per cent of completion on three dredging contracts valued at $5.76 million.

In the International Rapids section, 628 men were at work on 112 contracts valued at $35 million and had attained 25 per cent of completion. At the Welland ship canal, with 500 men employed, dredging and excavation valued at $21 million were 20 per cent complete.

Nearly $20 million worth of equipquired for operation of the locks and movable spans, such as lock gates of the mitre and sector type; stiffleg derricks, diesel generators, pumps, electrical control desks, lighting and heating fixtures and many other items.

At the St. Lambert lock the downstream entrance wall was 65 per cent complete and the concrete for the lock chamber about 60 per cent completed. Placing of concrete in the upstream entrance wall was just being started. The intake was completed and ready for permanent operation.

Some 30,000 cubic yards of concrete was placed at the Côte St. Catherine lock during June, bringing the concrete to 55 per cent of completion. Earth excavation was half done and rock excavation 85 per cent completed.

On the upper and lower Beauharnois locks, estimated to cost some $29 million, work was proceeding at a rapid pace. With all excavation substantially completed, placing of concrete was proceeding at both locks. The four-lane tunnel to carry highway traffic on highway No. 3 under the lower lock, comprising two tubes of two lanes each, was partially opened to traffic early in June. Fabrication of two movable bridge spans over the Beauharnois canal was also under way.

At the Iroquois lock, which will be the first of the five Canadian locks to be completed, all concrete for the lock structure proper and for the upstream guide and guard walls had been placed by end of June. Still remaining are the guide and guardwalls at downstream end. Completion of the lock is expected for November several months ahead of schedule.

The raising of the Jacques Cartier bridge to provide for 120-foot clearance over the seaway channel was being carried on night and day under the continuing liveload of motor traffic. The whole of the southern half must be raised some 50 feet. On the night of June 9 traffic was halted an hour to place a 'climbing jack' beneath the superstructure at pier 11, where the steel had already been raised some 4½ feet. Plans have been set for the swinging in of a new span over the channel at piers 10 and 11 on November 2.

At the south approach to the Mercier highway bridge, construction of the new concrete piers to carry future road traffic 120 feet above the channel was proceeding rapidly.

On the Welland ship canal, of the six contracts awarded for enlarging the existing channel and providing a governing depth of 27 feet, two contracts had been completed by the end of June and two others were nearing completion.

Seaway News

The Cement Situation Being Watched

With peak demand expected this year for cement on the seaway and power project, officials of Ontario Hydro and Canada's Seaway Authority are attentively watching cement statistics. Canada's productive capacity has been sharply increased over the past year for placing concrete on the seaway project. Because of the reluctance of many customers to place their orders early and stockpile, there may not be enough handling and transportation facilities to fill cement orders for the seaway when it is wanted.

Last year, Canada's total consumption of cement was estimated at over 32 million barrels, which included some 3.3 million barrels imported. This year Canadian construction activities generally are expected to at least equal the 1956 volume. Imports are at about the same level as last year, but exports to date in 1957 are running about a third higher than in 1956. About 3 million barrels are expected to be required for seaway navigation and power structures this year, and almost a third of it will be exported for use in the American section of the power development.

Giant Freighter-Tanker Proposed

A new 27,500-ton tramp freighter for carrying grain and petroleum through the seaway has been proposed by the U.S. Maritime Administration. Grain Fleet, Inc., which already operates three ships in bulk trades, has applied for a construction subsidy and a federal mortgage insurance on the vessel. It will be of novel design, and may be the prototype of a new American flag tramp fleet.

The ship would be the largest planned for seaway traffic. Grain Fleet officials say the ship would be unable to take its full 'lift' through the channels but would be limited to about 16,000 tons of cargo. Experienced tanker men are skeptical about the feasibility of carrying grain and oil on an alternating basis each voyage. But company spokesmen claimed it would be profitable despite the fact that cleaning petroleum tanks for carriage of edible products now costs $20,000 each time.

Tolls

Dr. Pierre Camu of Laval University believes 'very low' tolls should be levied when the seaway opens for navigation in 1959, to attract traffic. "A system might be established", he told the Geographers Association meeting in Quebec City on June 9, "so that during the 1960-65 period annual revenues might be only $5 to $10 millions. This figure could be increased to more than $25 million yearly after 1975 until the end of the 50 or 40 year period needed to recover the cost of the project."

Professor Camu also suggested that tolls be applied regionally. It would be unfair to charge all ships the same toll regardless of whether they were using one or a few sections of the seaway. Also to be worked out, he stated, is who is to collect the tolls. "We hope," he said, "that both countries will agree to set up only one organization. It should be in Montreal, the ideal trans-shipment centre and the entrance and exit of the whole system".

No Pilot Shortage Seen for Seaway

No pilot shortage is anticipated on the St. Lawrence, even with the increased demand from shipping once the seaway becomes a reality, said Louis Hemond, secretary-treasurer of the United Montreal Pilots, in June. No plans were in the making for expanding the organization's membership. Canada has about 50 pilots operating between Montreal and Kingston, he reported, while one hundred were employed for piloting vessels between Father Point and Montreal and an equal number between Quebec and Montreal. American pilots on the Great Lakes, he said, had been complaining Canadian pilots were guiding ships in American waters, and had lodged a warning with Washington authorities on this basis, that sufficient numbers of U.S. pilots would not be available once the seaway is completed, if the practice were permitted to continue.

Bridge Construction at Montreal

Privy Council President The Hon. Lionel Chevrier, in an election speech at Montreal on June 6, stated that Canada's Seaway Authority was building ten bridges to improve road and rail traffic over the seaway channel. Of these, seven are located in the Montreal area, not counting the new and expensive modifications being made to the four metropolitan bridges and their approaches.

"We will be spending some $25 million for bridges in the Montreal area", he revealed. "In addition there will be the future Nuns' Island Bridge, which the Canadian government has decided to build. Plans of this bridge, construction of which is assigned to the National Harbours Board, are in preparation."

Canadian Pipeline Projects

Westcoast Transmission Company

Westcoast Transmission's pipeline will be delivering gas by August 1, two months ahead of its scheduled completion date. The Company has denied the rumor that a large section of the pipeline had been found defective and had to be replaced. During tests of one shipment an unusually large number of breaks were found, but that portion of the pipeline had all been tested again and was ready for operation. Pipe shipped in 1957 has all tested satisfactorily and no further trouble is expected.

Craig and Ralston Construction Co. crews were running tests in June on a 400-mile section of Westcoast's main pipeline between Prince George and the International Border. Tests call for specialized equipment and techniques. The pipe is blown up with water or air pressure to 1170 pounds per square inch — actually more than operating pressures.

The contractors had some 80 men and $800,000 worth of equipment on the work. They also have contracts in the Fraser Valley for 35 miles of 2-inch, 4-inch and 6-inch lines for British Columbia Electric Co. Pipe laying was completed by mid-June in the Langley area and crews had started work on the Albion-Mission distribution systems.

"The demand for natural gas on the West Coast is growing at an almost unbelievable pace" states Paul Kayser, president of El Paso Natural Gas Co., Westcoast Transmission's biggest customer. His company has contracted to provide an additional half million cubic feet daily to its western market where population is growing at three times the national average.

Trans Canada Pipelines

Charles S. Coates, former executive vice-president of Trans Canada, has been elected president, with headquarters in Toronto. Former president N. E. Tanner has been elected chairman of the board, with headquarters at Calgary. Mr. Tanner became president of Trans Canada Pipelines in 1954.

Late in June it was reported that Bannister Construction Co. had started June 12 laying 18 miles of a 10-inch branch line from Trans Canada to serve Brandon. Rapid progress was being made and completion was expected early in July. Canadian Bechtel Ltd., on section 6 between McGregor and Ile des Chenes, was making progress of a mile a day of 34-inch pipe. Canadian Parkhill Pipestringing Ltd. was stringing at the rate of two miles a day and had reached the Ile des Chênes compressor station by the middle of June.

Price-Poole on their 34-inch spread for section 4 resumed work on June 1, and were making progress of 8,000 ft. daily. With 80-ft. double joints they have been able to keep the 'firing line' crew down to 20 weld-

A 357-foot section of 34-inch diameter pipe is ready to be pulled across the Red River south of Winnipeg, in the Trans-Canada Pipe Line's line to Eastern Canada. The 40-foot lengths of pipe have been welded into the long section. Weights will hold the pipe in a ditch below the river bed.

ers, half the number needed on single joints. Marine Pipeline and Dredging Ltd., completed the first section of their 34-inch gas line crossing of the Red River south of St. Norbert on June 15. The second section will be ready for pulling early in July.

Majestic Contractors had commenced rock-drilling on section 7 on their 30-inch spread between Ile des Chênes and the Manitoba border. Pipe deliveries are expected early in July. On this section the pipe has to cross the Greater Winnipeg Water District railway and aqueduct, five road crossings and two railway crossings. Clearing was completed early in June.

Tenders closed on May 28 for three 110-mile sections of the 24-inch Toronto - Montreal pipeline. Awards had not been announced by the end of June, but a start is expected in July.

Union Gas Co. of Canada

Union Gas Company reports sales of 15.2 billion feet of gas for the year ending March 31, 1957, up from 13.5 billion the previous year. Customers at year end totalled 98,672, an increase of more than 5,000 over a year ago. Residential heating customers increased to 45,000.

Construction of the Company's large diameter pipeline from Dawn storage fields is expected to be completed by December. Among the new markets to be served are Hamilton, Guelph, Stratford, Kitchener, Waterloo, St. Mary's and Strathroy. It is hoped gas can be turned on in the new markets by December 1. It is the company's intention to continue this expansion to other towns and villages not now served with natural gas as and when extensions can be justified.

Union Gas awarded contracts in June for a distribution system in Guelph to Majestic Contractors, and distribution systems in Stratford and Strathroy to J. W. Carn.

Consumers Gas Co. of Toronto

Consumers Gas Co. of Toronto sold 10 billion cubic feet in the first seven months of the current fiscal year, up 81 per cent compared with a similar period a year earlier. The relative increase in revenue at 44 per cent did not keep pace in sales volume due to a downward price adjustment made to customers during the period.

In Metropolitan Toronto some 30,000 houses are heated with natural gas compared with 4,000 a year ago. In Ottawa, Interprovincial Utilities Ltd., acquired in May 1957, will be ready to distribute natural gas when it arrives from the west. Interprovincial presently serves 2,300 customers with manufactured gas. Consumers' expansion program from 1957 to 1962 inclusive is expected to cost some $75 million.

Work is under way this year for some 300 miles of distribution lines for Consumers Gas Co. in the Toronto area. Majestic Contractors, F. E. Shaw, Ltd., the Somerville Co. Ltd., and Mid - Canada Contractors are sharing the work.

Trans Canada to Supply Regina

Trans Canada has signed a contract with the Saskatchewan Power Commission for 10 million M.M.cfd. over a 20 year term. The contract is designed as a stopgap until use can be made of reserves in West Saskatchewan and Eastern Alberta.

More Gas Export Deals Shaping Up

A battle is shaping up respecting Alberta's gas reserves and what markets each should serve. Trans Canada and Westcoast are each trying to sign up gas purchase deals to support much larger export programs. Other interests, involving a third gas export proposal, are seeking to sign up long term purchase contracts. Price of gas has been bid up to 12 cents per Mcf at wellhead, up 20 per cent from what Trans Canada originally paid.

Tennessee Gas Transmission's purchase contract from Trans Canada comes up for renewal in November. With competing U.S. pipelines seeking gas from both of them, prices are likely to be revised upwards. Trans Canada's efforts to buy more from producers before any deliveries are made hint Trans Canada officials feel an F.P.C. decision will be in their favour.

All this points to the likelihood of larger exports of Canadian gas to the U.S., probably at higher prices. The Alberta Petroleum and Conservation Board will have to take another close look at its entire reserve position.

Association Meetings Discuss Gas

D. K. Yorath, president of Canadian Western Gas of Clagary, addressing the Canadian Investment Dealers Association meeting on June 14, predicted that acceptance of gas would be more rapid than forecasts. By 1980 gas would supply a quarter of the total energy used in Canada.

Capital expenditure of $2 billion within the next five to seven years on gas development was reasonable, he believed, in view of the $25 billion outlay suggested by the Gordon Commission over a 25 year period. This, he said, was supported by the experience of the British Columbia Electric in Vancouver, and Consumers' Gas in Toronto. The price of gas, he believed, would rise to a point where it may be just competitive with other fuels, and if so it would be selling itself on convenience, efficiency and quality alone.

R. H. Dean, president-elect of IDA will ask incoming executive to consider means whereby the two groups of security dealers, investment dealers and stock brokers, could present a united front, thereby taking their place more forcibly beside such united groups as the Canadian Bankers Association of Canada.

Fred R. Palin, general manager of Union Gas, president of the Canadian Gas Association told the C.G.A. meeting at Jasper on June 25 that the gas industry must ensure that investors retain their confidence in it and that the consumer must be made a satisfied customer. He called for an adequate investor relations program to assure the attraction of required capital and to keep before the investor the importance of the expanding gas industry to the Canadian economy.

Two New Pipe Mills

Mannesmann Tube Company's new $20 million tube mill was officially opened at Sault Ste. Marie, Ontario, on June 17. Production, scheduled at 225,000 tons yearly is expected to attain a speed of one tube every 20 seconds on a site leased from Algoma Steel Corporation. Production will be primarily for the Canadian oil and gas market.

Prairie Pipe Manufacturing Co.'s $3 million Regina pipe mill is now in full operation, with a a rated capacity of 75,000 tons yearly.

Copper Mill in B.C.

Financing has been completed and construction will start immediately on British Columbia's first copper mill, according to a recent announcement by Richard M. Reiner, president of Western Copper Mills Ltd., Vancouver.

The project, which was originally announced over a year ago as a $3½ million investment, will now be in excess of $8 million. It will be completely under-written by Canadian funds.

Originally scheduled to employ 200 workers at full capacity, the plant on completion is expected to employ 350 with a maximum capacity of 18,000 tons annually.

Financing has been arranged by the national financing house of Gardner & Co. Ltd. Toronto, with Western Development & Power Ltd. forming part of the original investment group.

The plant will be located on 15 acres of leased land on the Annacis Island development. It will have 170,000 sq. ft. of floor space with integrated mill and its own casting shop. The administration building will be additional.

Initial production is scheduled for late 1958.

Machinery will be of the latest and most modern type manufactured in the United States and Canada with some specialized items from Europe.

Products will cover a wide range of industrial and domestic applications such as seamless copper, brass and bronze tubing and pipe for condenser and heat exchangers, refrigeration, automotive and marine service and copper tubing for domestic water supply.

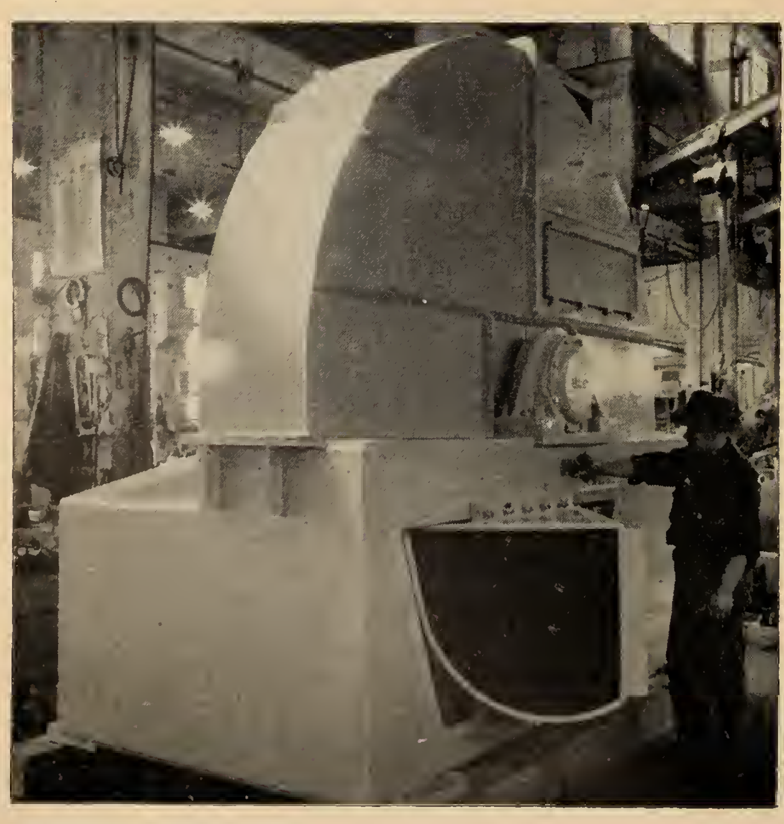
For the electrical industry, a variety of items is scheduled for production, principally buss bars for high as well as low tension switchgear installations, etc.

Other industrial products will be a complete line of brass rods and shapes, and copper rods for the local wire and cable mills.

Using mainly Canadian and U.S. copper, the mill will supply the needs of Western Canadian industry primarily and will also seek markets across Canada and abroad.

Decision to build the mill was prompted by the rapid industrial growth of the western provinces now supplied by eastern Canadian sources; the proximity of Vancouver to raw materials, and the advantages it holds for export.

Dimensions of the huge 112-inch chipper to be installed in the new B.C. Forest Products pulp mill at Crofton, V.I., are well illustrated in this picture, taken just before the machine was shipped. Designed by Hansel Engineering Co. Ltd., Vancouver, the chipper was built by Vivian Diesels and Munitions Ltd. It will consume a whole log up to 25 inches in diameter.



Record Year for Roadbuilding

A recent survey records that all governments plan to spend $861 million in Canada this year on roadbuilding. This is a 20 per cent increase over 1956, when the total budget was $715 million.

The Canadian Good Roads Association made the survey of road and street budgets on which these statements are based.

Provincial highway budgets account for $604 million, for year ending March 31, 1958. This is 70 per cent of the total road budgets of all governments, and is an increase of 24 per cent over provincial expenditures on roads in the previous year.

On the basis of contract reports it is estimated that municipal governments will spend $167 million, an increase of nine per cent.

Federal government plans to spend $71 million, compared with $62 million in 1956.

The Province of Ontario is the largest roadbuilding agency in the country, with a current budget of $236 million. The Province of Alberta will spend the largest amount per capita on its roads and streets.

The same development is evident in the current year as in every year since the war: while paved road mileage has been increasing steadily, the number of automotive vehicles has been increasing. This year's registration figures will be as high as 4.4 million. The concentration on the highways has grown to 21.4 vehicles per mile of surfaced highway, as compared to 11.6 per mile in 1946.

Every government faces this increasing pressure of traffic, and sees in continued economic growth the likelihood of more congestion.

A substantial backlog of road needs exists, states C.G.R.A., and it is conceded generally that long-range programs are indispensable. This same need exists in the field of urban street redevelopment.

Ontario Department of Highways has made a survey forecasting the Province's needs for the next 20 years. C.G.R.A. says that the study illustrates that the development of roads can be made to keep pace with demand and at a substantially lower cost. The planned approach brings about economy and efficiency.

Alberta Power

Calgary Power Limited's Wabamun plant, 42 miles west of Edmonton, combines natural gas, air and water into useful electrical energy by producing high pressure steam which drives a steam turbine and directly coupled electric generator.

The Wabamun plant is an important part in the Company's continuing construction program, required to meet the rapidly growing electric power load in Alberta. Completed in 1956, with an initial rated generating capacity of 66,000 kilowatts, the plant will be extended by means of a second 66,000 kilowatt unit now on order for installation in 1958. A third 120,000-kw. unit is scheduled for 1960.

The plant is presently using natural gas from the Alexandra Field. Eventually it will convert to coal to be supplied by a nearby deposit of 66 million tons.

In the main, the Company's load has been met over the years by the construction of plants on the Bow River and its tributaries, west of Calgary. These plants now serve an extensive high voltage transmission system which is interconnected with the other major electric utility systems in Alberta, and with the East Kootenay Power Co. in British Columbia. Eleven plants already constructed represent one-sixth of the estimated potential hydro power in the province.

Power Requirements Increased

In 1956 the Company's load was over 1,300 million kilowatt hours. This represents a 325 per cent increase over conditions of 1946, as compared to a 225 increase for all of Canada over a ten-year period.

The addition to the Company's load of 200 million k.w.h. per year is explained by the tremendous growth in industry, and the interest of the growing and prosperous population in more electrical appliances and in farm electrification.

The Wabamun development, commissioned in October 1956, is the first thermal power plant built by the Company. The base load has grown to the point where large thermal plants can be operated at near maximum capacity almost continually, thereby decreasing operating costs to a minimum, while taking advantage of the lower capital cost per unit of capacity for a large steam plant. These advantages are combined with the low fuel costs in Alberta and the relative proximity of thermal plants to load centres.

Thermal and Hydro Power

Integration of hydro and thermal plants is under way. Development of remaining hydro-electric plant sites in the province presents some economic problems. However the Calgary Power plan is that generating capacity can be substantially increased at low cost by installing additional generating units in existing hydro plants and by constructing new hydro plants with a generating capacity that is the maximum attainable, to operate in conjunction with base load thermal plants.

A second 23,000-hp. unit is being installed at Cascade, to be completed this year. Second units at Spray and Rundle, totalling 97,000 hp., scheduled for 1959 are under consideration.

By the fall of 1960 the Company's hydro plant capability will be 320,000 kilowatts. When the third unit is installed at Wabamun, the thermal capability, including 25,000 kw. received under contract with the City of Medicine Hat, will be 287,000 kw.

What Goes On

Ore Bridge Shipped

A new ore bridge was scheduled for assembly early in July in the Steel Company of Canada steel mill in Hamilton. The last major part of the 375-foot coal carrying ore bridge—the 20-ton main hoisting unit—was shipped from the Welland plant of United Steel Corporation Limited in June.

The ore bridge is designed to remove coal from lake freighters at a rate of 1200 tons per hour. Its cost is approximately $1.5 million, and it requires more than a year to complete.

The installation of such equipment is an indication of the increased capacity of Canadian steel producers.

Highway Reclassification

The Saskatoon Department of Highways and Transportation has completed a preliminary reclassification of all roads and streets in the province, it was announced recently by Loyde T. Holmes, Deputy Minister of Highways. This was undertaken in conjunction with a comprehensive reorganization of the planning activities of the highways department.

Foreign Investments

Mannesmann Tube Company officially marked the opening of its seamless steel pipe plant at Sault Ste. Marie, Ont., in June.

The financial editor of the *Toronto Daily Star* commented that this development, coupled with the opening of the St. Lawrence Cement's Clarkson plant, results in $50 million in European money going to work in the Canadian economy.

Baffin Island Mining

Ultra Shawkey Mines is doing exploration and drilling on Baffin Island on claims which may prove up a large deposit of concentrating-type magnetite iron ore.

Costs of a mining development on Baffin Island would be up to $150 million, which would require the annual production of 12.5 millions tons of ore.

Other mining groups are known to be interested in Baffin Island which has been reported to contain base metals and coal.

Financial Post, June 15.

THE ANNUAL MEETING

Minutes of the 71st Annual General Meeting

The seventy-first annual meeting of The Engineering Institute of Canada was convened in the Ball Room of the Banff Springs Hotel, Banff, Alberta, on Wednesday, June 12, 1957, at ten o'clock a.m. with President V. A. McKillop in the chair.

The president extended a welcome to all present and commented on the fact that it was just nine years ago that an annual general meeting had been held in Banff. At that time the attendance was about six hundred. This year it was expected to be at least fifty per cent more, a very encouraging sign, marking the growth of the organization.

The minutes of the seventieth annual general meeting as published on pages 1054 and 1055 of the August 1956 *Journal* were taken as read and approved.

Nominating Committee

The membership of the Nominating Committee of the Institute for the year 1957 is as follows:

Chairman C. V. Antenbring, Winnipeg

Branch	*Representative*
Amherst	J. N. Ritchie
Belleville	W. E. Van Steenburgh
Border Cities	C. G. R. Armstrong
Brockville	F. F. Walsh
Calgary	K. W. Mitchell
Cape Breton	M. R. Campbell
Central Br. Columbia	A. F. Joplin
Corner Brook	
Cornwall	D. Ross-Ross
Eastern Townships	R. D. Mawhood
Edmonton	E. K. Cumming
Fredericton	D. J. Brewer
Halifax	J. W. MacDonald
Hamilton	N. A. Eager
Huronia	R. D. Marsh
Kingston	S. H. Rochester
Kitchener	M. A. Montgomery
Kootenay	A. F. Brooks
Lakehead	T. M. Olsson
Lethbridge	E. A. Lawrence
London	I. D. Patterson
Lower St. Lawrence	Marcel Lanouette
Moncton	W. M. Steeves
Montreal	Dean H. Gaudefroy
Newfoundland	H. J. Hermanson
Niagara Peninsula	C. G. Cline
Nipissing and Upper-Ottawa	R. A. Booy
North Nova Scotia	R. S. Morrow
North Eastern Ontario	J. B. Fredericks
Northern New Brunswick	T. H. McSorley
Ottawa	T. Foulkes
Peterborough	B. Ottewell
Port Hope	E. M. Wynn
Prince Edward Island	E. K. MacNutt
Quebec	Jean St.-Jacques
Saguenay	D. W. Stairs
Saint John	T. C. Higginson
St. Maurice Valley	John F. Wickenden
Sarnia	J. E. Harris
Saskatchewan	G. N. Munro
Sault Ste. Marie	R. A. Campbell
Sudbury	A. D. Finlayson
Toronto	J. G. Hall
Vancouver	F. M. Cazalet
Vancouver Island	A. G. Ballantyne
Winnipeg	T. E. Storey
Yukon	H. L. Meuser

Honorary Memberships

The general secretary reported that the following had been elected to honorary membership in the Institute and that certificates would be presented at the luncheon on Friday, June 14:

J. Omer Martineau, B.Sc., Assistant chief Engineer, Department of Roads, Province of Quebec, Quebec, Que.

Andrew George Latta McNaughton, C.H., C.B., C.M.G., D.S.O., D.C.L., LL.D., M.S.C., Chairman, Canadian Section International Joint Commission, and Chairman, Canadian Section, Canada-United States Permanent Joint Board on Defence, Ottawa, Ontario

Penrose Melvin Sauder, S.P.S., Toronto, Manager and Colonization Manager, St. Mary and Milk Rivers Development, Alberta Government, Lethbridge, Alta.

William Stewart Wilson, B.A.Sc., Assistant Dean and Secretary, Faculty of Applied Science, University of Toronto, Toronto.

Awards of Medals and Prizes

The general secretary announced the various awards of the Institute as follows, stating that the formal presentation of these would be made at the luncheon on Friday, June 14.

Sir John Kennedy Medals — "As a recognition of outstanding merit in the profession or of noteworthy contributions to the science of engineering or to the benefit of the Institute", to Richard Lankaster Hearn, M.E.I.C., Consulting Engineer, Hydro Electric Power Commission of Ontario, Toronto, Ont.; and to Irving R. Tait, M.E.I.C., formerly Chief Engineer, Canadian Industries Limited, Montreal, Que.

Julian C. Smith Medal — "For achievement in the development of Canada", to Edward Victor Buchanan, M.E.I.C., formerly General Manager, Public Utilities Commission, London Railway Commission, London, Ont.

Gzowski Medal — "For the best paper of the medal year on a civil engineering subject, "civil" being used in the limited sense to indicate structural, surveying and construction work generally." to — David Bernard Steinman, M.E.I.C., Consulting Engineer, New York, N.Y., for his paper, "The Design of the Mackinac Bridge".

Duggan Medal and Prize — "For papers dealing with the use of metals for structural or mechanical purposes", to Douglas Tyndall Wright, Jr.E.I.C., Queen's University, Kingston, Ont., for his paper, "The Design of Compressed Beams".

Leonard Medal — "For papers on mining subjects", to George Arthur Jewett, M.C.I.M., Scheduling Engineer, Riotinto Management Service Limited, Toronto, Ont., for his paper, "Sampling Design and Grade Estimation of Mineral Deposits".

Ross Medal — "For papers on electrical engineering subjects", to William Russell Way, M.E.I.C., vice-president, Shawinigan Water & Power Company, Montreal, Que., for his paper, "Growth and Development of Large Electric Power Systems".

John Galbraith Prize — "For best paper by a Junior in the Province of Ontario" to Nicholas Edward Hudak, Jr.E.I.C. Supervisor - Application - Engineer Canadian Cutler-Hammer Limited, Toronto, Ont., for his paper — "Trends in Design of Electrical Distribution for Industrial Plants".

ANNUAL MEETING

Seven former presidents of the Institute were at the President's Dinner: left to right: T. H. Hogg, Toronto, L. F. Grant, Kingston, J. N. Finlayson, Vancouver, J. A. Vance, Woodstock, J. B. Stirling, Montreal, D. M. Stephens, Winnipeg, R. E. Heartz, Montreal. The host, V. A. McKillop, retiring president, is at extreme right.

Incoming president C. M. Anson and party receive guests at the annual dance. Seen at Mr. Anson's right, Mrs. Anson and Mrs. McKillop.

Below, at the annual banquet head table: Mrs. McKillop, the banquet speaker Mr. Justice S. Freedman, and President McKillop.

his photograph shows a part of the session of the new council. For want of space lentification is omitted, with the exception of W. A. Smith (left foreground), hairman of the Alberta annual meeting committee.

Below, President McKillop (left) with Dean Hugh Conn, chairman of education conference, 1957.

Report of Council, Report of Financial Committee, Financial Statement and Treasurer's Report

Mr. Dunsmore, vice-president and chairman of the Finance Committee, summarized his report and pointed out that the complete report and financial statements were in the annual report of Council, copies of which had been distributed as a supplement to the April 1957 issue of *The Engineering Journal* and also at this meeting.

Mr. Emerson, the treasurer, presented the treasurer's report and commented on the close cooperation given the treasurer by the general secretary and his staff. His report also was included in the annual report of Council.

On the motion of H. R. Sills, seconded by E. H. Wright, it was resolved that the report of Council, the report of the Finance Committee, the financial statement and the treasurer's report be accepted and approved.

Committee Reports

In referring to the annual reports of the committees, the president expressed his appreciation of the work done by the committees throughout the year. He wished it clearly understood that the work done was greatly appreciated even though the reports of all the committees are passed on a single motion. He reminded the meeting that the work of the Institute was largely the work of the committees.

On the motion of W. A. Capelle, seconded by R. E. Hayes, it was resolved that the reports of the following committees be taken as read and approved: Admissions, Board of Examiners, Life Members Committee, Professional Interests, Legislation, Prairie Water Problems, Papers, Publications, Library Report, Employment Service, Library and House, Report of Field Secretary, Ontario Division, Canadian Chamber of Commerce, Canadian Standards Association.

Branch Reports

On the motion of M. A. Montgomery, seconded by F. W. Orlando, it was resolved that the reports of the branches be taken as read and approved.

Confederation

The president asked Dr. I. R. Tait, chairman of the Institute's Committee on Confederation, to report to the meeting.

Dr. Tait stated that the subject had been discussed in some detail on the day previous at the joint meeting of the Council of the Institute and the Branch Officers Conference. The outcome of that meeting was that the matter had been referred back to his committee for further study and report. However, he was glad to have this further opportunity of reporting to the membership at large.

He stated that the Institute's committee had been practically at a standstill for the past year inasmuch as they were waiting for a report from the committee of the Dominion Council. This report had been received just a few days ago and was the basis of his report to Council.

The Dominion Council's report was an encouraging one but would require considerable study before any formal comments could be made. However, on the whole he and his committee were quite encouraged.

Dr. Tait went on to report that it was now his hope that the two committees would get together and form a joint committee so that a joint report might be prepared within a reasonable period of time.

Dr. Ballard referred to an item on the Dominion Council's report which limited membership in the national body to "membership in provincial and territorial associations and the Corporation of Professional Engineers and that there is no other way that full membership may be obtained." Dr. Ballard's observation was that this would be an impossible position as far as the national body was concerned inasmuch as there were many engineers practising in Canada who are now, or who might wish in the future, to be members of the Institute but who were not registered. Such persons would include many of the engineers in the services of the Federal Government including the armed services.

Dr. Ballard also referred to new Canadians who, at least in the Province of Quebec, are not permitted to register in the province until they have become Canadian citizens which would take a minimum of five years' time.

Dr. Tait said that attention had been called to this proposal and that he realized the difficulties associated with it. He added to the list mentioned by Dr. Ballard, distinguished engineers who reside in other parts of the world and who now belong to the Engineering Institute. He felt it would be unwise to propose that such persons be denied membership in the Canadian national organization.

Mr. Thoms of Edmonton inquired as to the reasons for Confederation. He felt that the purpose of the associations was to regulate the practice of the profession whereas the Engineering Institute's purpose was to disseminate technical knowledge. In his opinion it would be a mistake to try to combine the two.

Mr. Hanna of Calgary was interested to know if faster progress could not be made. In reply Dr. Tait reminded him that it was the wish of the Institute's committee to merge the two committees now to accomplish the purpose Mr. Hanna had in mind.

Federal Election Act

Mr. Sillitoe of Belleville stated that he had been denied the privilege of voting at the advance poll before he left home. He felt the privilege of voting in advance should be made available to more people than enjoyed it today. He recommended that Council approach the Federal Government to have this corrected. Mr. deJong of Vancouver supported Mr. Sillitoe's proposal as did also Colonel Grant of Kingston, Ontario, and Mr. Wardle of Ottawa.

The general secretary reported that for some time he had been in correspondence with the officials at Ottawa on this very matter. Unfortunately he had received no encouragement but he hoped that this meeting would give him instructions to follow the matter further.

Eventually it was agreed that the general secretary should communicate with the leaders of each federal political party urging upon them the desirability of making the privilege of the advance poll available to all persons who for adequate reasons were unable to be at their permanent residence for voting purpose on the date of the election.

The following telegram was sent to Mr. St. Laurent, leader of the Liberal party, Mr. Diefenbaker, leader of the Progressive Conservative party, Mr. Solon Low, leader of the Social Credit party and Mr. M. J. Coldwell, leader of the C.C.F.

The Engineering Institute of Canada at its seventy first annual meeting today passed unanimously the following resolution. "In view of the fact that members of the profession of engineering in Canada are required on many occasions in the ordinary execution of their duties to be absent from their homes on election day, it is unanimously agreed that the Federal Government be requested to so revise the election act that the privilege of voting at the advance poll be extended to engineers and others similarly situ ated. It is the very essence of de mocracy and in the best interests o Canada that no citizen be denied hi fundamental right for any reason. Th very existence of the advance pol proves the truth of these statements For example here at this Banff meet ing, arranged five years ago, there are over a thousand voters all o them disenfranchised for the recen election."

Engineering Students

Professor Lash of Kingston, inquire as to what Council proposed doing tc wards improving the approach to th engineering students on the campuse across the country.

The president replied that the officer of the Institute appreciated the impor ance of the student, and were plai ning several changes that should in prove the Institute's services. He poin ed out that recently the Institute h: appointed a faculty representative c each campus who for all general pu poses would represent the Institute each university. Each of these represen atives had been given one hundred dc lars to be used in furthering the Insi tute's usefulness to the student. Tl president was very optimistic of tl move and believed excellent resu would follow.

The general secretary amplified tl president's remarks by stating that meeting was taking place that very a ternoon between several of the repı sentatives who were at the annual mee ing. Many suggestions for new polici would be discussed at that time.

Mr. Wright stated also that duri the president's visit to several branch an abundance of new ideas had be developed relative to means by whi the Institute could improve its usef ness to students.

Mr. de Jong of Vancouver stress the desirability of the present memb of the Institute taking some share the responsibility for the developme of the students. He felt that the membership by their example could do a great deal to enhance the status of the Institute with the students and that the present situation was a challenge to the entire membership as well as to the Council.

Election of Officers

The general secretary presented the list of the newly elected officers of the Institute as follows:

President

C. M. Anson, Sydney

Vice-Presidents

S. C. Montgomery, Trail
W. J. Ripley, Copper Cliff
Albert Deschamps, Montreal

Councillors

Yukon Branch	John L. Phelps
/ancouver Island Branch	P. F. Fairfull
Vancouver	W. O. Richmond
Central British Columbia	M. L. Wade
Kootenay	W. K. Gwyer
Edmonton	R. N. McManus
Saskatchewan	W. L. Sharpe
Winnipeg	W. D. Hurst
Lakehead	E. T. Charnock
Sudbury	F. A. Orange
Nipissing and Upper Ottawa	R. R. Prescott
London	G. E. Humphries
Port Hope	R. C. Wilson
Belleville	S. Sillitoe
Kingston	C. H. R. Campling
Brockville	J. S. Waddington
Ottawa	W. B. Pennock
	R. E. Hayes
Toronto	K. F. Tupper
Montreal	J. H. Budden
	R. B. Winsor
Saguenay	A. B. Sinclair
Lower St. Lawrence	L. P. Dancose
St. Maurice Valley	W. G. Seline
Eastern Townships	G. J. Cote
Corner Brook	E. Leja
Newfoundland	Wm. Watson
Prince Edward Island	W. S. Veale
Amherst	A. G. Baxter
Halifax	W. A. Devereaux
Fredericton	S. B. Cassidy
Saint John	A. G. Watt
Border Cities	P. S. Dewar

Vote of Thanks to Retiring Officers

Past-President Stirling of Montreal proposed that a vote of thanks be extended to the retiring president and retiring officers of the Institute. As a past-president he had some appreciation of the work that was entailed in the presidency. He knew that Mr. McKillop had worked very hard at his task and had produced excellent results. He emphasized the amount of time required to the presidency and he was glad to join with others in expressing to the retiring president their appreciation of his splendid contribution.

In reply Mr. McKillop stated that while the office did require a certain amount of time and effort he felt indebted to the Institute for the high honour and the privilege of serving which had been given to him. During his year of office he had come to a greater realization of what the Institute means to the profession and to the country at large. He had come to a greater appreciation of the work being done by the engineers both professionally and in community activities. This had led him to a greater appreciation than ever of the profession.

Mr. McKillop also commented on the inspiration he had received from the officers of the Institute who had preceded him. He concluded by saying "Please accept our thanks for your appreciation but in turn accept our thanks for the opportunity".

Finance Committee

Mr. Dunsmore asked the privilege of expressing his appreciation to the members of the Finance Committee with whom he had been associated for so many years. This committee was made up of leading heads of industry who gave freely of their valuable time to aid the Institute in its management. He thought that few organizations had a committee as strong as this one. He wished particularly to commend their work to the meeting. Mr. Dunsmore's remarks were greeted with applause.

Mr. Anson, the president-elect, wished to make a motion expressing appreciation from the members to the Headquarters' staff of the Institute. In this he was supported by Mr. McKillop who said it had been a great pleasure working throughout the year with the Headquarters' staff. This proposal was greeted with applause.

The meeting adjourned at eleven thirty a.m.

Branch Officers' Conference

At 9:30 on Tuesday morning about twenty-five branch officers met in the Oak Room to hold their annual conference. The purpose of this meeting is to permit these representatives of branch management to discuss freely, among themselves, Institute projects and policies which are of closest interest to them, and from the branch point of view.

The branch delegates first nominated and installed their own chairman, in the person of Colonel W. A. Capelle of Ottawa. The choice was a prudent one, and he proceeded to conduct the discussions with efficiency and wisdom throughout the day. Assistant General Secretary E. C. Luke was on hand to provide any information required from Institute headquarters staff.

The agenda was a long one, covering almost all facets of E.I.C. activity and affairs. Among the topics which received special attention from the branch officers were Institute publications, high school student counselling, attendance at meetings, professional development courses, technical sections, regional meetings, participation of non-members in branch programs, and the scale of annual fees.

In accordance with custom, after the lunch break the branch officers were invited to join the council meeting, to hear the reports and discussion on confederation, and one or two other subjects. They resumed their own deliberations later, and concluded their business about 5:30 p.m. Nothing of an urgent nature arose from the day's work, but several important memoranda and resolutions were adopted for the future attention of Council.

Students' Conference

Once again, the E.I.C. Students' Conference was held concurrently with the Annual Meeting of the Institute. Fourteen delegates were present, representing the universities across Canada and Royal Military College. Three observers from the engineering student body of the University of Alberta were also present.

The conference began at 9 a.m. June 11th. Following brief words of welcome and encouragement from President V. A. McKillop, incoming President C. M. Anson and General Secretary L. A. Wright, the delegates tackled the conference agenda with enthusiasm. Under the able chairmanship of J. F. Harris, JR. E.I.C., discussion was lively and participation by the delegates was excellent. Philippe Lemay, S.E.I.C., was appointed secretary for the conference.

The first part of the conference was devoted to student activities in the Institute. How to make these activities more valuable, how to make membership drives more effective, these were some of the topics discussed. Employment conditions and salaries for summer employment were also discussed. Some concern was expressed about the difficulties of first and second year students in finding work providing engineering experience.

A Resolutions Committee of three members was elected to summarize the work of the conference into resolutions to be presented to the Council of the Institute. The committee members elected were: J. N. Fry, S.E.I.C., E. J. Muszinski, S.E.I.C., and N. Seagram, S.E.I.C.

The second part of the conference was devoted to student engineering societies at the various universities. J. F. Riel, S.E.I.C. was elected chairman for this portion of the conference.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE ELECTIONS AND TRANSFERS

Disenfranchised

The Canada Election Act provides that an advance poll will be available to certain classes of citizens who, because of their occupation, are unable to be at their homes on the date of a national election.

Unfortunately the persons permitted to use the advance poll are very limited in numbers and in classification. Some time ago the general secretary wrote to the government a protest on this situation but a quite unsatisfactory answer was received.

The question was raised at the Annual General Business Meeting in Banff on June 12. Many members complained that they had been unable to vote because they had to leave home for the annual meeting on or before the date of the election. The outcome of the discussion was that the general secretary was instructed to wire the Right Honourable Louis St. Laurent to propose that the privileges of the advance poll be made available to engineers and others similarly situated right across Canada.

Copies of the telegram were sent also to the heads of the other three political parties, including Mr. Diefenbaker. The acknowledgments have been received from all four leaders, but of course no promises can be made at the present time and under the present circumstances.

It was interesting to learn that in the province of Saskatchewan the privilege of the advance poll is already available to all citizens. Is it too much to hope that the federal authorities will be able to learn something from the province of Saskatchewan?

Herewith is the message sent t[o] the then Prime Minister.

"The Engineering Institute of Canad[a] at its seventy first annual meeting toda[y] passed unanimously the following reso[lu]lution. In view of the fact that member[s] of the profession of engineering in Can[n]ada are required on many occasions i[n] the ordinary execution of their duties t[o] be absent from their homes on electio[n] day it is unanimously agreed that th[e] Federal Government be requested to s[o] revise the Election Act that the privileg[e] of voting at the advance poll be extende[d] to engineers and others similarly situa[-]ted. It is the very essence of democrac[y] and in the best interests of Canada tha[t] no citizen be denied his fundament[al] right for any reason and the very exist[-]ance of the advance poll proves th[e] truth of these statements, but it is a[n] injustice to limit its application to so fe[w] citizens. For example here at this Banf[f] meeting arranged five years ago ther[e] are one thousand voters all of them di[s]enfranchised for the recent election."

E.I.C. Education Conference (1957)

Although the minutes of the recent education conference held in Banff are not yet ready for distribution there are some interesting things that can be reported now.

There were thirty-eight delegates representing sixteen universities. The chairman was Dean Hugh Conn of Queen's. Six resolutions were passed for the consideration of the Council of the Institute. These are being studied now for final presentation to the next meeting of Council. Here are the resolutions:

ference held last year justifies th[e] vision of the Council in sponsorin[g] this activity in a field of such wid[e] importance to Canada.

The members of the conference ar[e] particularly appreciative of the o[p]portunity thus provided of meetin[g] with their fellows from other unive[r]sities and colleges and discussin[g] common problems, an accomplisl[h]ment which would otherwis[e] have been difficult or impossible.

Conference Committee

1. *Resolved* that this Conference on Engineering Education (1957) express to the Council of The Engineering Institute of Canada, its deepest appreciation for making this second conference possible. The success of this conference and the con-

2. *Moved* by Dean R. E. Jamieso[n] *seconded* by Professor J. L. deStei[n] and *carried*, that:
"The chairman of this conference a[p]point a standing committee of eng[i]neering educators with power to de[al] directly with The Engineering Inst[itute]

Cover Picture

The cover picture shows a view from the apex of the dome which will form part of the containing structure of the Canada-India nuclear energy research reactor, which is now being built near Bombay. The design and much of the major construction work is due to Canadian engineers. An article on the design and operating features of the reactor starts on page 1099 of this issue.
(Photo: courtesy The Shawinigan Engineering Company Limited.)

. session of the Education Conference, 1957, at which sixteen Canadian universities 'ere represented by thirty-eight educators. Their resolutions are published herewith.

ite of Canada on matters of engi-ering education and to represent ie degree granting universities and olleges on matters of engineering lucation that may come before The ngineering Institute of Canada; and at this standing committee remain office until replaced or disband-l at a future conference or other athering representing the degree anting universities and colleges."

Education Committee

Moved by Dean D. L. Mordell, *conded* by Professor L. E. Gads d *carried*, that:

'his conference recommends that e Council of The Engineering Insti-te of Canada consider establishing Committee on Engineering Educa-n to concern itself with matters of gineering education that come be-e The Engineering Institute of nada; and that the standing com-ittee of engineering educators uld welcome an invitation to work h The Engineering Institute of nada Council in setting up such mmittee on Engineering Edu-cion."

Scholarship Program

4. *Moved* by Professor L. A. Madonna, *seconded* by Professor L. P. Bonneau and *carried*, that:

"This conference recommends to The Engineering Institute of Canada Council that they consider establishing a scholarship program to encourage secondary school teachers to improve their professional status through advanced study at a university in order that they may contribute to the number of inspired teachers, so badly needed at the high school level, and that no restrictions be placed on such an award insofar as the field of study is concerned."

During the discussion of this motion, it was the feeling that action as recommended, would help to dispel the generally expressed feeling that engineers are merely trained, are not educated and are interested only in equipment, money, buildings and staff insofar as they may benefit engineering education and not education in its broader sense. The number and size of the scholarship should be left to the discretion of Council.

Postgraduate Registration

5. *Moved* by Dean R. E. Jamieson, *seconded* by Professor J. F. M. Muir, and *carried* that:

"This conference recommends consideration of some plan which would tend to encourage greater numbers of our Canadian-trained graduates to proceed to postgraduate study in Canadian universities."

During the discussion of this motion, it was pointed out that, while substantial numbers of our graduates are at present proceeding to higher degrees, there nevertheless are many others, fully capable and qualified, who elect to develop their careers from the bachelor's level only. It was felt that many of these graduates would profit from post - graduate study, and would thereby enhance their eventual position in the profession, and their value to their country. It was suggested that, while assistance in the form of scholarships, teaching assistantships, and so forth, are quite widely available, there is not much in the way of a centralized Canadian effort to reach the students, and the initiative rests largely with the individual student. The success of the Athlone Fellowships was cited as a case where centralized application, competition, and selection appear to be features which attract many of our outstanding graduates, and the opinion was expressed that this element of centralized competition, coupled with direct personal interviews by the selection committees, has been a beneficial factor. The plan envisaged in the resolution would, in effect, parallel the Athlones in the machinery of applications and selection committees, but would be for Canadian-trained graduates and for post-graduate study in a Canadian university.

Teaching Standards

6. *Moved* by Dean D. L. Mordell, *seconded* by Professor Frank Noakes and *carried*, that:

"It is the wish of this conference that the Council of The Engineering Institute of Canada be informed of the concern which members of the conference have for the maintenance of high teaching standards in the face of increased enrolment. The members are fully cognizant of the natural tendency to meet the greater demand by increasing class size and teaching load and allowing crowding in laboratories, to the detriment of good education. While realizing there are practical problems to be met and solved in providing optimum teaching facilities, the members of the conference will continue to strive for those things that permit close contact with students, so essential to good teaching and the provision of engineers of good quality."

Representation

The universities represented were as follows: University of British Columbia, University of Alberta, University of Saskatchewan, University of Manitoba, University of Toronto, Queen's University, McGill University, Ecole Polytechnique, Laval University, University of New Brunswick, Nova Scotia Technical College, Hamilton College (McMaster), University of Ottawa, Carleton College, University of Sherbrooke, Waterloo College.

The above list includes every university in Canada except one, where engineering is being taught in a degree course.

It is planned to publish more later about the deliberations of the conference and the plans for the future.

The Institute Publishes A Book

Throughout its entire seventy-one years the Institute has been in the publishing business, but never before has it published a full length book. However the thought behind this effort is just the same as that behind all previous publishing efforts — to render a service to the profession.

This publication "Daylight through the Mountain" is a historical biography of two early Canadian engineers who almost a century ago set standards for the profession, and gave it even then a status in the community. They largely, were responsible for lifting Canada from the horse and buggy days and bringing it rapid transportation.

The Shanly brothers, Walter and Francis, left behind them in letters from and to each other the exciting and frequently amusing story of their lives. These letters were found in the archives at Ottawa and other Canadian and American cities, and in the possession of surviving relatives. They were gathered together and put into manuscript form by Dr. Frank Norman Walker and Mrs. Walker of Toronto. It was through these diligent and intelligent searchers and workers that the Institute was given the opportunity to publish the material in book form.

Here is a great segment of the history of the profession of engineering in Canada, never before brought to light or to the attention of today's engineers. The Council of the Institute have authorized this publication because they felt the Institute had a responsibility in preserving the history of its members and their work. Walter Shanly was a vice-president of the Institute at the time of its founding in 1887.

There are other biographies which the Institute proposes to publish later but future ventures will be influenced by the manner in which this one is accepted by the profession. Copies may be obtained in the book stores, but if purchased through Headquarters by members of the Institute the price will be $5.00 instead of the regular price of $6.00.

Don't miss this exciting story of the early days of the profession of engineering in Canada.

Aviation Writers Meet In St. Louis

The nineteenth annual meeting of the Aviation Writers Association presented a number of novelties which were noteworthy even for the Aviation Writers Association which always produces some novelties.

To this writer the outstanding feature was the flight in the French jet liner, *Caravelle*. Judging by the remarks of other delegates they too regarded the experience as exciting and novel. After all there are no jet liners operating regularly and commercially on this continent, so naturally the experience was new to almost all writers.

The plane's interior was a delight to the eye. Trust the French to present a decor that was outstanding. On looking back on the experience one wonders what it was that made the interior so pleasing and acceptable. There were no features that stood out as unusual or noteworthy and yet the "ensemble" was effective. Perhaps its simplicity was the reason.

Of course the real difference between this and the internal combustion job, from the traveller's point of view was the absence of noise. Once the public get used to this sort of travel it will be hard to satisfy them with anything else. Even a jet prop is noisy by comparison.

The plane's take-off was a delightful experience. It was very much like being in a rocket — or so it seemed. The acceleration was unbelievable. Rising on what looked like 35 deg. angle it was no time before 20,000 feet and 500 miles per hour were reached.

At this level the plane was put through its paces, much to the satisfaction and delight of everyone. As one would expect, champagne was served aloft. By the way, the *Caravelle* is made by the Sud Aviation Corporation of France and is powered with Rolls Royce engines.

Air Show

On the same day that the *Caravelle* was demonstrated the group was shown through the plant of the McDonnell Aircraft Corporation which is situated right alongside the Lambert-St. Louis Municipal Airport and which of itself is really something to see. It makes the Can-dian airports look pretty mediocre.

McDonnell's put on an air show that was remarkable in many ways, not least of which was that it was carried out on a commercial airfield operating at full head without interrupting commercial travel. It was a great job of weaving in and out that says much for the facilities and staff of the airport. All the planes in the show were McDonnell products.

The flight show included a cross-country speed dash by an F-101 A *Voodoo,* said to be the fastest fighter in the world; short field take-off, high speed climb, and short field landings; fly-by of F 3H-2 *Demons* equipped with various external stores, and low-level "buddy" refuelling of F3H-2 by another of the same kind.

Here again it was the out-of-the-ordinary plane, that caught the eye and the imagination. The company is working on a "convertiplane" for the army. The machine was flown and gave a first class performance but not too much information was divulged except to say — as one could see — that the plane was a combination machine. Vertical flight was provided by the horizontal propellors as in a helicopter and horizontal flight was provided by an internal combustion engine placed horizontally. It appeared to be very maneuvrable and of course had a much higher horizontal speed than a helicopter. Such a plane should have many uses when the bugs are eliminated.

On to Kansas City

The second day was spent in Kansas City, Mo., seeing something of the facilities of Trans World Airlines. Recently the company has taken over a great area of the Mid-Continental Airport for runway facilities, engine overhaul, test cells and hangars. The engine overhaul deserves a paper for itself and so do the other facilities as well. In fact an effort is being made now to get some papers on these features for the *Journal.*

Westinghouse were hosts for lunch after which the group flew to Olathe, Kansas, the Naval Air Training Station for an exhibition of what the navy boys could do. Unfortunately Mother Nature took a hand in things and put on a demonstration of thunder, lightning and rain that dwarfed man's best efforts.

However, some brave souls of the Goodyear Rubber Company proceeded with their scheduled demonstration. They blew up and flew a tiny all-rubber plane. The pilot handled the machine (if that is the right word for it) as if it were a normal low speed metal craft. Details of this oddity will appear in a later *Journal.*

Eventually it was agreed that the rain had taken over on what seemed a permanent basis so after dinner at the Officers Club, the group boarded the T.W.A. Constellation that had brought them over in the morning and returned to St. Louis.

Wichita Day

Wednesday's opening event was a 7.00 A.M. flight to McConnell Air Force Base at Wichita, Kansas. That is a modest and truthful statement of what occurred but the details provide the colour. The flight was made in four Air Force Lockheed C-130's. Therein lies the colour and several other things. These big monster troop and freight carriers are something to see and hear, and even more to ride in. They sit almost flat on the ground with a ramp at the rear end for loading. The inside diameter must be 14 feet and there are no windows other than a row of port holes at the halfway level.

The power units are turbo props (Allison) of constant speed. This feature produces some very odd effects. A person gets used to the changing sounds of aircraft engines and learns what each means, but here the sound was constant, and flying blind as the passengers were, nobody could tell when we had taken off or when we had landed. On top of this, the plane seemed to have no insulation against sound. It must have been a funny-looking sight for the crew to see the four longitudinal lines of puzzled civilians, strapped to the benches on which they were sitting, half in and half out of their parachute harness, their ears stuffed with protruding rolls of cotton, and not a word being uttered. It was a dizzy noise-drunk group that landed at Wichita, one hour after takeoff.

The hosts here were the Air Force, the Boeing Company, The Cessna Company, and the Beech Aircraft Corporation, and they did a good job although to a Canadian it seemed there was an overdose of self-commendation by some of the manufacturers.

Here also there was an air show—both static and in flight. In fact it was the liveliest show of its kind that this writer has seen in a long time. Both civilian and service craft were flown and a great variety of operations were carried out, including gliding, refuelling, formation flying and a variety of aerobatics — and the weather was perfect.

A Slack Day

Thursday was unusual because the first event (a business session) was not until 9.00 A.M. The program said "sack time, courtesy of the committee". It was well received. Most of the day was given over to Association business, but there was a dinner in the evening courtesy of the Air Transport Association. The speaker was vice-president of the First National City Bank and he spoke on the financing of air transport companies. He referred to the present need of purchasing new and up to date equipment, and from the cost figures which he presented, it appeared as an almost impossible task. Back of it all, this reporter sensed a feeling that the speaker was soliciting the support of the writers in softening up the public for a substantial increase in rates.

After the address the group was treated to a rare and exciting film. It was a colour record of the successful trials of the Ryan "Convertijet". Much has been reported on this craft which takes off and lands vertically but tips over and flies horizontally once it is well off the ground. Here was real proof of its existence and its success. It was of interest to discover by questioning, that the engine was a Rolls Royce Avon, it being explained that this was the only engine available powerful enough to do the job. There is something quite exciting about this machine.

Last Day

Friday started out with a 7.15 a.m. breakfast, followed by a panel discussion on Aviation Safety. The short speeches of the panel members and their replies to questions from the floor left one with the impression that he was lucky if he ever had a flight without an accident. Another point emphasized was as that rules for safety had been drawn up and agreed upon by experts long ago but that the authorities had done nothing to have them adopted. It took the Grand Canyon double disaster to really awaken them to the situation.

Luncheon was a feature, playing up "Le Chateau Village" and its "Dejeuner Francais". The restaurant which is outside the city is most attractive and the meal served was the best of the whole conference but to a resident of Quebec the French atmosphere was not noticeable. Lockheed Aircraft were the hosts.

That afternoon there was the final business meeting and the election of officers, and in the evening the banquet for which A.W.A. was the host to the many kind people who had done so much for the delegates through the strenuous week. Hon. Garrison Norton, Assistant Secretary of Navy for Air was the speaker.

Homeward Bound

Early Saturday morning saw all the out-of-town delegates scrambling for their accommodation on the return airlift. It required seven planes to do the job — and in all directions.

It was a good meeting, and the local committee accomplished miracles in putting the program together. It is hoped that later issues of the *Journal* will present some of the technical information that was divulged. Also there are prospects of getting some very good movies of a technical nature for the Institute film library.

The 1958 meeting will be in Houston, Texas.

Canadian Management Council

B. A. C. Hills M.E.I.C.

Editor's Note: The following article on the Canadian Management Council has been prepared at our request by the president of the Council, who is a member of the Institute.

From its inception the Institute has had an important part in the affairs of the Council, therefore it is a pleasure to publish this article which will bring the members of the Institute up to date on the work of the Council.

The Canadian Management Council (CMC) was formed in 1947 to represent Canada in the International Organization for Scientific Management (Comite International de L'Organisation Scientifique, known as CIOS). Basically CIOS is a committee composed of representatives of 27 countries which for the past thirty years has been organizing management conferences to facilitate the interchange of views on philosophy and practice of management at the international level. Canada's first official participation was through papers presented at the Stockholm Conference of 1947. Two years later, in conjunction with the Engineering Institute of Canada, CMC organized a Western Hemisphere Management Conference in Quebec. In succeeding international congresses at Brussels, Sao Paulo and in Paris (held in June, 1957) CMC has taken an active part in the program.

In addition CMC contributed an important paper at the Pan-American Congress of CIOS held in Santiago in 1956, and has corresponded with a number of other countries on management subjects. It has played host to a number of visitors of other nations, particularly Finland, Australia and Brazil.

But while it is important and gratifying that Canada should be represented in this international exchange of knowledge and ideas relative to the field of management, it was felt by its original sponsors that CMC could play a useful part in acting on behalf of its member societies in certain directions *within* Canada. The member societies are those interested directly or indirectly in management and include:—

- Engineering Institute of Canada
- Society for Advancement of Management
- Institute of Administration
- National Office Management Association
- Canadian Industrial Management Association
- Canadian Industrial Trainers' Association
- Society of Industrial and Cost Accountants of Canada
- Chartered Institute of Secretaries
- Porcupine Institute of Administration
- Montreal Personnel Association
- Toronto Personnel Association.

It will be seen that the society members fall into two groups — one, those associations which have been constituted in order to cover some particular field of management, such as NOMA, SAM, CIMA, IA and PIA, and a second group of associations which cover activities in a functional field such as engineering, cost accounting, personnel and secretarial. But both groups are interested in a common field — that of general management.

Council of Members

CMC is *not* a separate body, competing with any of its society members, but instead it is a *council* of these members, formed by them and supported by them. It is considered that the time has arrived when the society members should use their council in order to centralize some of their activities in the *general management field.* Examples of the kind of work which CMC could undertake of this nature are as follows:—

1. Compiling a register of the educational facilities in the management field available in Canada.
2. Making arrangements with universities throughout Canada so that library and research facilities in management subjects will be available to company members.
3. Assisting society members by building up a roster of qualified speakers on management subjects, drawing on the experience of the various society members.
4. Serving as a permanent means of exchange of information in connection with such matters as workshop seminars, conferences, and educational courses.
5. Holding senior management conferences in various centres when and where required. The outstanding success of the meeting held in Montreal in 1955 shows the great need for Canadian sponsored conferences which will help the development of professional management in Canada.

This could best be achieved through a small permanent secretariat in order to ensure continuity of operation as well as providing full time attention to and direction of those projects which the society members decided should be undertaken in the common interest. It would have the added advantage of providing in one place information relative to the activities of all the societies in the management field.

The idea of one organization to co-ordinate efforts to spread the knowledge of general management and to provide a means of exchange of ideas is, of course, not new. The United States have four such bodies and would like to reduce the number; Australia, South Africa and the United Kingdom each have a single body labelled Institute of Management. But Canada is the only nation which has in CMC a means of combining the efforts of all those interested in the general management field which has not been superimposed upon existing societies and associations. We have, in fact, the perfect means — a council which consists of the existing societies, which is run by the existing societies, and which depends upon them for its own existence. What is now required is to activate this body so that it makes its maximum contribution in increasing our knowledge of management and in making available that knowledge to as many Canadians as possible. CMC is the tool which all member societies can use in their desire to increase and make available this knowledge.

The first step is active participation by the presidents or permanent officers of the member societies in the *direction* of CMC. It has been proposed that they should become Directors of CMC so that they can the more directly combine in determining on behalf of their various associations the projects which CMC can most usefully undertake in addition to representing Canada on CIOS. It is hoped that the response will be such that we shall indeed see a virile council of the representatives of such important professional bodies as E.I.C. as well as of those directly interested in management.

The Canadian Conference on Education

Out of the conviction of many people that wider public understanding of Canada's educational needs and problems would be a major step toward their solution have grown plans for the Canadian Conference on Education, to be held in Ottawa on February 17-20, 1958.

Attempting to focus attention on the objectives and needs of education in Canada in the next decade, the conference will seek ways and means to meet them. Examining the educational needs of our society and of the Canadian economy, it will also give attention to the needs of the individual. In particular, it will study such matters as organization and curricula, quantity and quality of teaching personnel, financing of education, encouragement of youth to proceed to further education and training beyond high school. It will discuss the role of the home, and agriculture, business and industry and organized labour in education. Other key topics to be included in the discussion are physical well being, mental health and the social development of children and youth as well as education for leisure.

With advance study groups exploring the various areas of discussion, the Conference plans call for opening plenary sessions at which outstanding speakers will highlight Canada's main educational problems and those likely to confront us in the next decade. The middle portion of the Conference will consist of workshops. The concluding general sessions will receive and discuss reports and make recommendations.

Chairing the over-all conference committee is Lt.-Col. K. R. Swinton, general manager of Thomas A. Edison of Canada Limited, who represents the Canadian Chamber of Commerce. Under this there is a steering committee of twelve persons as responsible for the planning, preparation and operation of the Conference. Max Swerdlow, director of education for the Canadian Labour Congress has been appointed chairman. George G. Croskery, secretary-treasurer of the Canadian Teachers' Federation will direct the Conference.

Nineteen national organizations make up the list of sponsors. Among them are the Canadian Association for Adult Education; the Canadian Mental Health Association; L'Association Canadienne des Educateurs de Langue Francaise, the National Council of Women, the Industrial Foundation on Education as well as the Engineering Institute of Canada.

Further information may be obtained from:

George G. Croskery, Director,
Canadian Conference on
Education, 444 Maclaren Street,
Ottawa, Canada.

Correction

It was stated that the gentleman shown with Sir Claude Gibb on Page 851 of the June issue was D. J. Matthews of the London Branch—whereas it is Col. W. A. Capelle, of Ottawa.

Furthermore, the accuracy of the lower caption on Page 850 was affected by the switch of the two pictures concerned. To describe the pictures as shown, the caption should have read: "Groups in Montreal and Toronto greet visiting lecturer. Left to right: Leo Roy, Montreal Branch chairman, Sir Claude, and Past President Heartz; Sir Claude, Toronto Branch chairman E. R. Davis, and President V. A. McKillop."

The editors regret that these errors should have been made in reporting so important an event as the most successful lecture series of Sir Claude Gibb.

THIRTY-FIVE YEARS AGO

Comment on the Journal of August, 1922

The editor of the *Journal* gave practically the whole of his issue for August, 1922, to reports of the proceedings of the British Columbia professional meeting, held in Vancouver on June 16 and 17, 1922, and to the publication of three papers presented there. One hundred and thirty members and some of their wives registered, mostly, of course, from British Columbia, but with a fair smattering from the other provinces. . . "The native ability and energy of our Pacific Coast engineers provided a gathering to be remembered with pleasure by all who attended;" thus the editor.

There were the usual social functions and visits, including an inspection of the Ballantyne pier, then under construction, where "the latest methods were pointed out, the product being of a very superior order." Some of the members were taken by the city to see the Seymour creek works of its water supply.

Institute affairs came in for their share of discussion. The meeting resolved unanimously to endorse the recommendations of the Committee on Policy, which were published here in abstract last June. By a similar unanimous resolution, the meeting suggested that the Institute should "strive for coordinated legislation throughout the Dominion" to govern the practice of engineering. It is doubtful if our various provincial acts are even yet coordinated to the extent envisaged by this resolution, though a start in that direction has been made by the establishment of the Dominion Council.

James Ewing, M.E.I.C., of Montreal, contributed a short, but comprehensive paper on "The Engineer and the Town Plan" to the proceedings; this evoked considerable discussion. There was little or nothing in Mr. Ewing's paper that had not been said a dozen times before, but it did bring together the basic ideas of town planning into small space. "The great trouble is that the need for town planning is never imperative, and seldom even apparent (until) its cost becomes prohibitive." . . . What was a little playful calf has become a ferocious bull that it requires some resolution to tackle."

Irrigation Studies

E. A. Cleveland, M.E.I.C., provided a paper describing irrigation in British Columbia. Most of the "foreigners" in his audience were somewhat surprised to learn that irrigation was necessary anywhere in the province. One whose acquaintance with British Columbia weather was limited to that of Vancouver might well be excused for such ignorance. However, areas around Quesnel, Kamloops, Summerland, Vernon, Grand Forks and Invermere have average annual precipitations below 20 inches and even Victoria has only about 28 inches, as against about 59 inches in Vancouver. And what precipitation there is in these low areas occurs largely in the non-growing season.

In 1922 there were 22 irrigation districts operating in the province, ranging from that at Vernon, with about 14,000 acres under water, down to those of much smaller area. The ten large ones accounted for about 35,000 acres or about 54 square miles.

The early private land and water companies had been expropriated and turned over to irrigation districts owned and operated by the water users themselves, or this change was in process. The oldest company was the one that had operated on Coldsteam creek near Vernon, which sold its first orchard only in 1893, though there was a "water record" on the creek dating back to 1868. "If . . . in the future . . . errors may be avoided which in the past made the way difficult, and additional attention given to new projects, there appears to be no doubt but that the industry will afford . . . ample justification for the confidence of those who pioneered it and for the pledge of public credit which has come to the rescue."

Eastern visitors must also have been interested in a description of coast logging methods by T. W. Fairhurst, A.M.E.I.C. They were then and still are very different from those prevalent in our eastern forests, naturally so because of the difference in the size of logs in the two areas.

Tribute to the Engineer

The editor reprints in this issue a tribute to the engineer by Dr Frank Crane, which originally appeared in the *American City*. It wasn't the quality of the tribute that caught my eye; it was the author's name. Frank Crane was the pastor of a church which I used to attend occasionally in my college days. He had a flair for "inspirational writing" and discovered that there was more money to be made as columnist than as clergyman, though I doubt if the term "columnist" had been invented in his time. Most of his writing wa on the Pollyanna side, which canno be said of today's moulders of publi opinion; it was immensely populai I can testify that he was an excel lent preacher.

The history of the Ontario Engi neers' Act was presented among th editorials of this *Journal* by Willi Chipman, M.E.I.C. After outlining th various steps in the "*mutilation*" o the original bill by the legislativ committee, he concludes, "The bi as passed has been reduced to a regis tration bill only." One gathers tha Ontario engineers were not too happ about the affair and that they wer hoping for early amendments whic would restore the bill to somethin like its original form, though th Ottawa Branch thought the Act " tremendous step towards the goal

There was little room for branc news in this *Journal*. Only eigl branches reported at all and mo of their reports were only of one (two paragraphs. The local newspap had given the Peterborough Branc a pat on the back for its interest i civic affairs. Several of the wester branches had entertained the secr tary of the Institute on his way bac to Montreal from Vancouver.

"Reforming the Calendar" was tl subject of a long letter to the edito The writer advocated a 28-day mon with 13 months in the year. The e tra day was to be at the beginni of the year, to be called "Ne Year's Day" and to have no dat In leap years, another extra day w to be inserted between the ne month — Sol — and the first July; this would be called "Sol (or "July O". Calendar reform is st a live topic, but its progress towa realization is slow, in spite of i manifest advantages. One scheme h been endorsed by several natio but seems not to appeal to the larg ones, notably to the United Stat

R.DEL

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

QUEBEC

C. A. Peachey, P.Eng. of the Northern Electric Company Limited, has been elected president of th eCorporation of Professional Engineers of Quebec.

Mr. Peachey graduated from the University of Toronto in 1927 in mathematics and physics, in that same year joining Northern Electric Company Ltd., as an engineer in the field of vacuum tube development.

He became a supervisor in the engineering group in 1930 and was later put in charge of shop methods. In 1954 he was appointed general manager of the communciations equipment division, including both the Montreal and Belleville plants of the company. He has been active over the years in both engineering and management affairs.

Mr. Peachey is a member of the selection committee of the Defence Research Board, a past president of the Canadian Management Council and was Canadian representative on the International Committee of Scientific Management at their International Management Congress in Belgium in 1951. He is also a past chairman of the Institute of Administration and, in 1951, was metropolitan chairman of the Canadian Red Cross Society campaign for Montreal.

Mr. Peachey has been connected with the Corporation of Professional Engineers of Quebec for many years; he has served on various committees and has been a councillor for the past two years. He has long been active with the Engineering Institute of Canada, having served for six years as a councillor and on numerous committees.

Special Meeting

Three hundred and seventy-five members of the Corporation of Professional Engineers of Quebec filled the Auditorium of the Physical Sciences Building of McGill University to capacity on Saturday, June 1. The Special Meeting had been called to discuss, approve or disapprove the implementation by Council of the conclusions presented in 1956 by the Committee on Directing Principles, particularly with respect to the practice of the engineering profession by limited liability companies.

C. A. Peachey, P.ENG.

The meeting was under the chairmanship of President C. A. Peachey, P.Eng. Dr. T. A. Monti, P.Eng. who acted as chairman of the committee on Directing Principles in 1955 spoke briefly on the report under discussion. He was followed by Mr. D. C. MacCallum P.Eng. who spoke in favour of the corporate practice of the profession and by Mr. Gilles Sarault, P.Eng. who addressed the meeting in favour of the individual practice of the profession. Other briefs were presented by Messrs. Hector Cimon, P.Eng., Georges Demers, P.Eng., Roger Desjardins, P.Eng., H. L. Hurdle, P.Eng., E. S. Kelsey, P.Eng., Maurice Royer, P.Eng., Paul Tourigny, P.Eng., and G. Lorne Wiggs, P.Eng.

The members present approved two motions: (1) that the opinion of the membership at large be obtained on this question and that the General Secretary be instructed to send out ballots together with a résumé of the arguments pro and con, made at the meeting, and (2) that the report under discussion be approved with the exception of section 10 dealing with the practice of engineering by limited companies.

A lot has been said for and against the practice of the profession of engineering by corporations and individuals, and it appears that a lot more is to be said before the question is resolved.

Staff Nomination

In view of the continuous development of the Corporation, the addition of an officer to the C.P.E.Q. staff had long been felt as a need.

In January, members were invited to suggest candidates for the new position of Public Relations Officer; some 150 applications were received.

The President and the Council of the Corporation take pleasure in introducing Mr. Robert Préfontaine, M.A. whose duties will be to better acquaint engineers with the Corporation, and the public with engineers. Under the direction of Mr. Pierre Bournival, P.Eng. General Secretary, he will work with the other senior officers of the Corporation: Mr. Jean Barcelo, P.Eng., Registrar and Mr. B. R. Lachapelle, P.Eng., Specialized Services Officer.

Born in Manitoba, Mr. Norbert Préfontaine holds B.A. and M.A. degrees and has completed the required credits for his Ph.D. He has had extensive experience in radio and has worked with the Canadian National Railways in Montreal as District Superintendent of the Department of Colonization and Agriculture.

Correction

A list of officers comprising the Council for the current year appeared in the June issue of the *Journal*. Unfortunately the name of Councillor O. S. Gislason was omitted from that list.

ONTARIO

Technician Registration

The first official certification of engineering technicians in Canada was carried out June 5 when Premier M. Frost presented certificates to six men.

The ceremony, held in the Council Chambers of the Parliament Buildings at Queen's Park, was attended by officials of the A.P.E.O. Included were John H. Fox, P.Eng., Toronto, Association president; Dr. George B. Langford, P.Eng., of the University of Toronto, and Blake H. Goodings, P.Eng., Association field representative.

The 16,000-member Association was the first engineering body in Canada to establish a plan to certify technicians in five grades. Announcement of the program was made earlier this year in the April issue of the *Journal*.

Premier Frost said he felt great satisfaction in knowing that the idea for certification of technicians originally came from his office. D. J. Collins of the Premier's staff, after receiving a report from the Department of Highways, recommended that some study be given to the establishment of an association to accord recognition to the many technicians in the province. On this suggestion a voluntary program was initiated by the A.P.E.O.

The APEO's certification program was based upon the fact that certification would encourage technicians to progress through the five grades to top efficiency, and would also serve industry as a method of defining the upgrading of technical employees, employment needs and salary structures.

It is estimated that there are some 50,000 technicians in Ontario.

Engineers in the News

Fred H. D. Haiblen, of Jedwin of Canada Ltd., 170 Bloor Street West, Toronto, states that the company has recently been awarded the Canadian and United States agency of Wilhelm Breitenbauch Maschinen fabrik Unna, Westfalen, Germany, manufacturers of wire working machinery. For several years Jedwin of Canada Ltd., has represented in Canada and the States the firm of Mueller & Schwamborn Maschinenfabrik, of Bruehl, Germany. This concern manufacturers steel wire rope and electric cable machinery.

Ian R. Dutton is associate editor of "Electronics Engineering", a technical publication of Maclean-Hunter organization in Toronto.

Mr. Dutton graduated in electrical engineering from the University of Toronto in 1951 and was latterly with J. A. Wilson Lighting & Display Ltd., Toronto.

John R. Platts, of The British Thomson-Houston Co. (Canada) Ltd., is sales manager of the company for Quebec and the Maritimes and is located at 758 Victoria Square, Montreal.

Harold A. Whincup, formerly with Ontario Hydro, Toronto Region, has accepted the post of construction and maintenance engineer with the North York Hydro Electric Commission. His office is at 5145 Yonge St., Willowdale, Ontario.

T. Petterson has been appointed director of the engineering staff of W. R. Watkins Co. Ltd., Toronto, wholesale distributors and representatives of industrial and aircraft products.

A graduate from the University of Toronto, Mr. Petterson was for four years production engineer of Dowty Equipment Ltd. Recently he was a technical representative with Rogers Majestic Electronics Ltd.

Gerald G. Fisch, of Bruce Payne & Associates, Inc., management consultants in Westport, Conn., has been named vice-president of the company.

Mr. Fisch who joined the company in 1955 and became its assignment director in 1956, was formerly with Canada Packers Ltd. He graduated in engineering from McGill University and later obtained degree in both management and engineering from the Massachusetts Institute of Technology. In his new position he will maintain headquarters in the firm's New York office and will coordinate activities in the area offices in Boston, Chicago, Atlanta, Montreal and Westport, Conn.

N. E. Wilson is chief engineer of the Approval Division of the Canadian Gas Association, 6 Hadyen St., Toronto.

Mr. Wilson graduated in mechanical engineering from the University of British Columbia in 1950. Prior to joining to Canadian Gas Association's staff he was with the fire prevention division of the Underwriters Laboratories of Canada.

Frederick R. Duncan, is associated with Frederick P. Varcoe, C.M.G., Q.C., in carrying on his practice of law as Varcoe, Duncan & Associates. He is located at 7 King Street West, Toronto. The firm also has offices at 77 Metcalfe St., Ottawa.

Mr. Duncan graduated in electrical engineering from McGill University in 1940 and followed this by a course in law at Osgoode Hall, Toronto. He has been following his practice as a barrister-at-law in Toronto.

BRITISH COLUMBIA

Engineers in the News

C. E. Oliver, has been elected mayor of Penticton at a recent mayoralty election in the Okanagan city. Mr. Oliver is general manager of the Oliver Chemical Company Limited, Penticton. He has been engaged in civil and community activities for many years and was reeve of Penticton district for ofur consecutive terms from 1932 to 1936.

Walter J. Hardy, has been appointed assistant mechanical superintendent, Canadian White Pine division of MacMillan & Bloedel Limited.

G. T. Hughes, formerly with Ripley and Associates, Vancouver, has taken an appointment as associate professor, department of civil engineering, at the Royal Military College, Kingston, Ontario.

F. Lee has been appointed distribution design engineer. Vancouver Island, with the B.C. Electric Company.

O. W. H. Roberts has joined A. B. Sanderson & Company Limited as contract engineer. Mr. Roberts was formerly with the Department of Highways Province of British Columbia, as divisional engineer in the Peace River district. He was regional maintenance engineer at Prince George when he resigned from the department.

William A. Dale has been appointed resident manager of the chemical cellulose mill at Port Alice, B.C. for Alaska Pine & Cellulose.

Joseph W. Fraser received the appointment as assistant resident manage at Port Alice, B.C. Mr. Fraser is a gradu ate of the University of British Colum bia.

J. S. Slater has been appointed gen eral manager, Pembina Pipe Line Lim ited, Calgary, Alberta.

Allan Gall has registered with th Oregon Board of Engineering Examiner to practise in that State.

Graham F. Somerville has been awarc ed the Association of Professional Er gineer's Gold Medal for heading th graduating class in applied science at th University of British Columbia.

V. Raudsepp has received the appoin ment of Deputy Comptroller of Wat Rights, Department of Lands and Fo ests, Parliament Buildings, Victoria.

L. E. Wight has been named ar manager of the southern interior regi of the B.C. Power Commission and S. Burnell will be area manager of tl central interior.

The Commission also announces C. **Wale** will be district manager at Wil ams Lake, B.C. and **Larry Harper**, no distribution supervisor for the Caribc will move to the district manager's po tion at Nakusp. **Basil Gale** has been a pointed district manager for the Colu bia Valley.

H. B. R. Graves, has been appoint production manager, with the B.C. Co crete Limited.

Robert W. Lasby, has been appoint mine geologist for Chibougamau Jacu Mines Limited, Chibougamau, Queb He was formerly at Copper Mounta B.C.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Charles McGill McKergow, M.E.I.C., emeritus professor of mechanical engineering at McGill University, died at Montreal on June 5, 1957.

Professor McKergow who was born in Montreal was a graduate of McGill University. He gained his engineering qualifications in 1903. He received a master's degree in engineering in 1904 following which he taught engineering at the University of Virginia.

Returning to Canada in 1906 he accepted an appointment with the department of mechanical engineering at McGill University and was named associate professor in 1912. He was awarded the chairmanship of the department in 1921. He remained there until his retirement as professor of mechanical engineering in 1947.

Professor McKergow joined the Engineering Institute as a Student Member in 1903, became an Associate Member in 1911 and transferred to Member in 1921. He attained Life Membership in 1943.

Nicol MacNicol, M.E.I.C., village engineer, Forest Hill, Ont., died suddenly at Toronto, Ont., on June 2, 1957.

Mr. MacNicol who was born at Barrie, Ont., was educated in Toronto at Parkdale Collegiate Institute and graduated in civil engineering from the University of Toronto in 1919. He began his professional career in Windsor, then joined a firm of consulting engineers in Detroit, Michigan. He also gained experience with the Toronto firm of James, Proctor and Redfern Ltd., as resident engineer. In 1923 he became Etobicoke Township engineer. Eight years later he resigned in order to become works commissioner for Forest Hill Village, Ont., which post he held until the time of his death.

Mr. MacNicol was past-chairman of the Canadian Section of the American Water Works Association; past - president of the Canadian Institute of Sewage and Sanitation and Federation director of the Institute for three years. He was chairman of the Toronto Branch of the Engineering Institute in 1940.

Mr. MacNicol joined the Institute as a Student Member in 1919. He became Junior Member in 1923 and was transferred to Member in 1935.

Arthur Albert Smith, M.E.I.C., former chief engineer of the Ontario Department of Highways, died at Toronto on June 5, 1957.

Mr. Smith was born at Loughborough, England, on February 27, 1897, and attended schools in that district. In 1897 he commenced his engineering studies in Birmingham as an articled pupil with the boro engineer of Kings Norton Council. He began work in 1900 as an assistant engineer to the Council and over the following ten years worked as an assistant engineer with several British consulting firms. He was engaged on railway construction and tramways reconstruction.

Beginning his career in Canada in 1910 he became a resident engineer

H. V. Anderson, M.E.I.C.

with the Canadian National Railway and the Toronto Suburban Railway. In 1914 he joined the Department of Public Highways of Ontario as assistant engineer. He became resident engineer in 1917 and two years later was named divisional engineer in charge of the construction of the provincial highway east of Toronto. Later appointments were those of assistant chief engineer in 1925 and chief engineer in 1928. He retired in 1951.

Mr. Smith joined the Institute as a Member in 1921. He attained Life Membership in 1955.

William Hurst, AFFIL. E.I.C., pioneer, engineer, chairman of the board of the Central Manitoba Mines Limited, and president and general manager of the Hurst Engineering and Construction Company, Winnipeg, died there on May 23, 1957.

Born at Ottawa, Ont., on January 1, 1877, Mr. Hurst received his education at public schools in Manitoba. In 1900 he became engaged in street building work with the City of Winnipeg, was later put in charge of brick and concrete sewers and was in 1905 named superintendent of sewerage and water works. He assumed charge of artesian wells, and of the foundation of a high pressure plant and intake from the river to the plant. He completed the deep well and screen-house intake for water and the discharge of steam from the Red River to a standby plant of the Winnipeg Electric Railway.

In 1911 he formed the Hurst Engineering and Construction Company, playing an extensive part in the early development of Winnipeg and outlying areas, being responsible for such works as the sewerage system for the town of The Pas, Man., and pavement, waterworks and sewerage projects for the City of Winnipeg, as well as five years maintenance work with the Canadian Pacific and Canadian National Railways.

Mr. Hurst was the inventor of the Hurst Frost Excavating Machine, the Hurst Auto Heater and the Hurst Fire Escape Tube. Named president of the Central Manitoba Mines Limited in 1933, he held the appointment until three years ago. At that time he became chairman of the board.

Mr. Hurst joined the Institute as an Affiliate Member in 1928.

Hope Vere Anderson, M.E.I.C., former director of marine services, Department of transport, Ottawa, died suddenly at New Canaan, Conn., on April 28, 1957, while visiting there.

Born at Motherwell, Lanarkshire, Scotland, on December 10, 1890, Mr. Anderson studied engineering at the Glasgow West of Scotland Technical College for four years, at the same time apprenticing with the Glasgow engineering firm of Messrs. Alley and McLellan. Finishing his training in 1910, he gained added experience for the two years as a designing draughtsman in Glasgow. Moving to Canada in 1912 his first position was with the International Marine Signal Company at Ottawa. The following year he transferred his services to the Department of Mines, also in Ottawa, and later that year received the appointment of mechanical engineer with the Department of Marine, holding that position until 1924. Named senior assistant engineer, Department of Marine at that time, he also became first assistant to the acting chief engineer. With the advent of World War II he was in 1940 named chief of aids to navigation. Outstanding in Mr. Anderson's career was his work in the conversion of the Dominion Lighthouse Depot at Prescott, Ont., to war work during World War II. The establishment produced an average monthly output of 9,000 depth charge pistols and primers for use by the R.C.N., R.N., and navies of other allies. For this he was awarded the O.B.E. He retired from professional duties in 1955, after forty-two years service with the Department of Marine.

Mr. Anderson joined the Institute as a Member in 1935.

Institute Honours and Awards

Presented at the Seventy-First Annual General Meeting

Gen. The Hon. A. G. L. McNaughton, (right) receives certificate of honorary membership from President McKillop.

HONORARY MEMBERSHIPS

Four honorary memberships were awarded this year to distinguished members of the profession: Andrew George Latta McNaughton, C.H., C.B., C.M.G., D.S.O., D.C.L., LL.D., M.SC., chairman, Canadian Section International Joint Commission, and chairman Canadian Section, Canada-United States Permanent Joint Board on Defence Ottawa, Ontario; J. Omer Martineau, B.Sc., assistant chief engineer, Department of Roads, Province of Quebec, Que.; Penrose Melvin Sauder, S.P.S., Toronto, manager and colonization manager, St. Mary and Milk Rivers Development, Alberta Government, Lethbridge, Alta.; William Stewart Wilson, B.A.Sc., assistant dean and secretary of the faculty of applied science, University of Toronto, Toronto.

General, The Honourable A. G. L. McNaughton, HON. M.E.I.C., C.H., C.B., C.M.G., D.S.O., D.C.L., LL.D., M.S.C.

At the outset it will be recognized by everyone in this room that for so distinguished a Canadian as General McNaughton it is impossible even to outline his career let alone do justice to it, in so short a period of time as is at our disposal.

He was born in rural Saskatchewan, at Moosomin, and was educated at Bishop's College, Lennoxville, Que., and at McGill University, from where he graduated in 1910 with a degree of B.Sc. in electrical engineering and an M.Sc. in 1912. In 1920 he received an honorary LL.D. from McGill University.

Overseas with the Canadian artillery throughout World War I, he was wounded, mentioned in despatches, and awarded the D.S.O. In 1918 he was general Officer Commanding the Canadian Corps Heavy Artillery with the rank of brigadier general. In 1919 he was named a Commander of the Order of St. Michael and St. George.

Appointed a member of a committee for the organization of the Canadian Militia in 1919, this was followed by his entry into the permanent force a year later, with the accompanying posting as director of military training and staff duties at National Defence Healquarters, Ottawa.

Deputy chief of the general staff in 1928, this appointment gave way to that of District Officer Commanding, Military District No. 11, Victoria, B.C. in 1928. He also continued studies in Camberley and London, England, along with his other activities.

In 1929, promoted to the rank of major general, he was appointed Chief of the General Staff at Ottawa. Later, in 1935, he became president of the National Research Council. The same year he was made Commander of the Bath.

He was joint inventor of the Cathode Ray Direction Finder in 1926 and in scientific research has been responsible for many contributions.

Recalled to the Army in 1939, he was appointed to command the 1st Canadian Division. As a lieutenant general he commanded the Seventh Corps in the Battle of Britain. Forced to return to Canada through indifferent health in 1944, he was granted extended leave. Later that year he retired from the army and was given the rank of full general in recognition of his outstanding service.

He was appointed to the Cabinet as Minister of National Defence in 1944. Following the conclusion of the war with Japan he resigned from the Government and became chairman of the Canada-United States Permanent Joint Board on Defence, which post he still retains. The following year he was appointed Canadian Representative to the United Nations Atomic Energy Commission, and later was named president of the Atomic Energy Control Board of Canada. He was the Permanent Delegate of Canada to the United Nations and representative of Canada on the Security Council during 1948 and 1949. In 1950 he became chairman of the Canadian Section, International Joint Commission, which appointment he continues to hold.

His honours have been numerous in Britain, the United States and Canada and include the Sir John Kennedy Medal of the Engineering Institute of Canada 1940; an honourary Doctor of Laws degree conferred on him in 1942 at the University of Birmingham; an honourary Doctor of Laws from the University of Saskatchewan in 1944; the Companion of Honour and Grand Officer of the Order of Leopold in 1946.

General McNaughton joined the Institute in 1914 as an Associate Member and was transferred to Member in 1927.

General McNaughton is one of our great Canadians who ranks with today's great men of any nation. No Canadian was ever more concerned with the welfare of our Dominion and to those who have an insight into his work in the International Joint Commission, this will be brilliantly evident. Canadian engineers are proud to have this great man in their ranks. He is a credit to the profession and by his sterling merits and performance raises the status of us all.

J. Omer Martineau, HON. M.E.I.C.

J. Omer Martineau, assistant chief engineer of the Department of Roads of the Province of Quebec was born at Quebec City and studied surveying at Laval University and civil engineering at Queen's University. He graduated from Queen's with the degree B.Sc. in 1915. After a short term of service with the R.C.E. in Canada, he joined the staff of the Department of Roads in 1916, and has served that body for more than forty years.

A member of the soil investigation committee of the United States National Research Council from 1936 to 1942 he has also more recently been a member of the Associate Committee on Soil and Snow Mechanics of the National Re search Council of Canada, and was a member of the N.R.C. sub-Committee on "Muskeg".

Mr. Martineau has been a member of the Institute of Traffic Engineers; the Portland Cement Association; the Association of Asphalt Paving Technologist; the Canadian Good Roads Association, and the International Road Congress. He was also chairman of the National Committee on Uniform Traffic Control Devices of the Canadian Good Roads Association, where he represented the Institute.

Mr. Martineau joined the Institute in 1935. Actively serving in the Quebec Branch of the Institute for years, he was elected chairman in 1945 and five years later was elected councillor. During 1954 and 1955 he was vice-president for the province of Quebec.

To the business of Council and to the many social activities of the Institute, Mr. Martineau brought the best of many things from the French culture. His English speaking associates are indebted to him and are grateful for the privilege of knowing him and of working with him.

Penrose Melvin Sauder, HON. M.E.I.C.

P. M. Sauder, whose name is synonymous with the development of water resources in the West is consultant to the Western Irrigation District and colonization manager of the Department of Water Resources of the Alberta Government in connection with the St. Mary River development.

Penrose Melvin Sauder was born near Preston, Ontario. He studied mechanical and electrical engineering and on gradution in 1904 from Toronto joined the staff of the Department of the Interior as a draftsman at Regina. The following year he was located as an assistant engineer and made the first rating of the Bow River at Seebe. In 1909 he established a system of hydrometric surveys in

J. O. Martineau

P. M. Sauder (left)

Alberta and Saskatchewan and during the same year received the appointment of chief hydrographer.

He was named assistant commissioner of the irrigation branch in 1910 and held this post until 1919. In 1920 he joined the staff of the Lethbridge Northern Irrigation District, serving for three years as division engineer. Later he was assistant project manager and from 1924 to 1941 carried out the duties of manager. In this work he was able to establish practical methods of co-operation with the farmers of the district.

Promoted to the duties of director of Water Resources in 1941 he retired three years later to become general manager of the Western Irrigation District at Strathmore, at the same time keeping in touch with the Lethbridge area.

His services as manager of the St. Mary River Development were called upon in 1947, however in 1950 his ability to combine engineering with the human factor was recognized by the Alberta government and he was appointed colonization manager of the development.

Mr. Sauder has maintained a strong interest in the Engineering Institute of Canada and the Association of Professional Engineers of Alberta and was instrumental in the formation of the latter. He was elected president of the Association, during the years, 1936-37.

With membership in the Engineering Institute dating back to 1908, he has served as Branch chairman, councillor in 1927, and vice-president of the Institute in 1939 and 1940. For several years he has been on the council of the Institute representing the Alberta Association.

In recognition of his work, the Julian C. Smith Medal of the Institute was awarded him in 1947. Two years ago the Agricultural Institute of Canada conferred on him an honorary membership.

Here we have another case of the young man who came West, and remained to conquer. Mr. Sauder now is so much a part of Western Canada that it is almost impossible to think of him as ever having been any place else. He is one of the outstanding servants of the people of this part of Canada, and the Engineering Institute is proud to recognize his life of achievement in public service by awarding him an Honorary Membership.

W. S. Wilson (right)

William Stewart Wilson, HON. M.E.I.C.

W. S. Wilson, Assistant Dean of the Faculty of Applied Science and Engineering of the University of Toronto, also holds the post of secretary of the faculty.

He devoted a number of years to military service during World War I, before embarking on the academic training which was to earn him a B.A.Sc. degree in 1921, at the University of Toronto.

He joined the 31st regiment of the Queen's Own Rifles of Canada in 1913, later serving with the 147th Battalion of the Canadian Expeditionary Force in 1916, and then with the 4th Division, 38th Ottawa Battalion until demobilization in 1919.

After a few years experience in the construction field he was appointed secretary of the faculty of applied science and engineering, and has held the post since that time.

His appointment to assistant deanship was made in 1914.

He joined the Institute as a Student Member in 1921. He has accompanied his years of membership in the organization with an active interest in its affairs. He was secretary-treasurer of the Toronto Branch from 1931 to 1937, chairman of the branch in 1942 and a member of Council for four years, beginning in 1944. He is also E.I.C.'s representative on the executive of the Engineers' Council for Professional Development.

In the eastern part of this great Dominion, not many engineers are better known than "Stew" Wilson. Thousands of young men have passed through the old "School" at Toronto, and all have been the better for the guiding hand he has had in their affairs. His many friends will attest willingly to his character and his personality, his interest in other people, his sympathy and support for all good causes, and his genuine friendship.

The Institute is proud to number him among their Honorary Members.

SIR JOHN KENNEDY MEDALS

The "Sir John Kennedy Medal" has this year been presented to Richard Lankaster Hearn, M.E.I.C., consulting engineer, Hydro Electric Power Commission of Ontario, Toronto, Ont., and Irving R. Tait, M.E.I.C., formerly chief engineer, Canadian Industries Limited, Montreal. Que.

I. R. Tait (right)

Richard Lankaster Hearn, M.E.I.C.

Richard Lankaster Hearn was born in Toronto and graduated from the University of Toronto in 1913 with a degree of B.A.Sc. In 1952 he received the honorary degree of Doctor of Engineering.

After graduation he worked for the Dominion Bridge Company at Lachine as a draughtsman, later transferring to the Hydro-Electric Power Commission.

From 1921 to 1924 he was assistant chief engineer with the Washington Power Company with headquarters at Spokane, Washington. In 1924 he came back to Canada as chief engineer and secretary-treasurer of the H. G. Acres and Company Limited; from 1930 to 1934 he was consulting engineer for the Dominion Construction Company and H. F. McLean Limited and was their chief engineer from 1934 to 1942.

In 1942 he returned to the Ontario Hydro as executive assistant to the chairman; later he was loaned to become chief engineer in charge of the supervision of construction of the Polymer Synthetic Rubber plant at Sarnia, Ont.

Again in 1944 he was loaned by the Hydro to act as Canadian Technical Advisor to the Public Utilities Division of the Combined Production and Resources Board at Washington, D.C. In 1945 he came back to the Hydro as chief engineer of design and construction. In 1947 he was made general manager and chief engineer of the Commission and in 1955 was appointed chairman.

Dr. Hearn is an honorary member of the Association of Municipal Electrical Utilities (of Ontario), a director of Atomic Energy of Canada Limited, Honourary vice-president and director, Ontario Safety League, and a Fellow of the Canadian Geographical Society.

In 1954 he was awarded the Julian C. Smith Medal by the Institute for "Achievement in the Development of Canada" and in 1956 was awarded the Ontario Association of Professional Engineers Medal for outstanding achievement.

Dr. Hearn joined the Engineering Institute as an Associate Member in 1920, transferring to member in 1925. He became a Life Member in 1955.

Irving Richard Tait, M.E.I.C.

Irving Richard Tait was born in Montreal and was an honours graduate from McGill University in 1913, with the degree of B.Sc. in electrical engineering. In 1954 Mr. Tait received an honorary degree of doctor of science from Clarkson College of Technology, Potsdam, N.Y.

Starting with a two years apprenticeship in the shops of the Canadian Westinghouse Company he transferred in 1915 to the Canadian Explosives Limited as project engineer. This company later became a subsidiary of Canadian Industries Limited (C.I.L.) In 1929 he became assistant chief engineer of the company and in 1939 chief engineer. In 1952 after C.I.L. was broken up he became consulting engineer. He is still consulting engineer with C.I.L.

E. V. Buchanan (left)

Although graduated in electrical engineering, Mr. Tait's field of interest included in almost equal parts, civil and mechanical engineering. During the first World War he was engaged in the design and expansion of war plants for Canada, Great Britain and the United States.

During the Second World War C.I.L. was the principal manufacturer of chemicals and explosives. Mr. Tait was responsible for the new plants which were built by the company in many parts of Canada.

Throughout his lifetime he has been associated with the Y.M.C.A., on the board of management, on the board of directors and on the finance committee. He is on the board of governors of the Sir George Williams College, Montreal, and was chairman of the building committee in charge of the new premises recently opened. He is a registered engineer in many provinces; a member of the American Society of Testing Materials and the Engineers Club of Montreal. He is a past president of the Heather Curling Club.

Mr. Tait joined the Institute as an Associate Member in 1921, transferring to Member in 1940. He was councillor in 1950-51, vice-president from 1952 to 1954, and has served on the executive of the Montreal Branch and as Branch chairman. He has been chairman of many Institute committees including the finance committee, the committee on professional interests, the publications committee, and is at present chairman of the Institute's committee on Confederation.

JULIAN C. SMITH MEDAL

The Julian C. Smith Medal has been awarded to E. V. Buchanan, M.E.I.C., general manager of the Public Utilities Commission, London Railway Commission, of London, Ont.

Edward Victor Buchanan, M.E.I.C.

Edward Victor Buchanan was born in Hamilton, Scotland, and educated there, graduating in electrical engineering from the Royal Technical College, Glasgow, in 1908.

He came to Canada in 1910 and was associated with H. J. Glaubitz, consulting engineer for the Ontario Hydro. He went to London, Ont., later in 1910 as resident engineer in charge of the erection of hydro-electric substations. He became electrical and waterworks engineer for the Public Utilities Commission in 1911 and general manager of the Commission in 1915. In 1936 he was appointed also general manager of the London and Port Stanley Railway. In December 1951, Mr. Buchanan retired as general manager of the Public Utilities Commission. Since then he has done consulting

R. L. Hearn (left)

work, and in 1953 was appointed managing director of Isotopes Products Limited, Oakville, Ont.

Mr. Buchanan joined the Institute in 1922, and was chairman of the London Branch, 1924-1925, Councillor, 1926-1927, and vice-president 1938-1939. He has represented the Institute on the Engineers' Council for Professional Development since 1946.

Mr. Buchanan has been particularly active in the affairs of the organized bodies of the Engineering profession. He started early as secretary of the Student Section of the Institution of Electrical Engineers in Glasgow. He was president of the Association of Municipal Electrical Utilities in 1917-1918; chairman of the Canadian Section of the American Waterworks Association, 1937-1938; and president of the Association of Professional Engineers of Ontario in 1950.

Mr. Buchanan is also president of the London Health Association which governs the Beck Memorial Sanatorium, chairman of the London and Suburban Planning Board, and is a past-president of the London Community Chest.

In 1948 Mr. Buchanan was awarded the George Warren Fuller Memorial Award of the Canadian Section of the American Waterworks Association, for "His outstanding service in the administration of waterworks and public utilities and for the development of public relations.

In December, 1950, Mr. Buchanan's great contributions were further acknowledged when the Hydro-Electric Power Commission of Ontario named its new transformer and frequency changing station at Pond Mills, near London, Ontario, the E. V. Buchanan Station."

DUGGAN MEDAL AND PRIZE

For papers dealing with the use of metals for structural or mechanical purposes, Douglas Tyndall Wright, Jr. E.I.C., assistant professor of civil engineering at Queen's University has received the award for his paper, "The Design of Compressed Beams".

D. T. Wright, JR.E.I.C.

Mr. Wright was born and educated in Toronto and graduated from the University of Toronto in 1949. Since then he has been active in structural research and design. Later, attending the University of Illinois, he received an M.Sc. degree for his research on the development of the high tensile bolted joint. He also worked on the plastic deformation of reinforced concrete from the point of view of large-magnitude impulsive loading. Granted an Athlone Fellowship in 1952 he worked at Cambridge, Eng., on the research team of Professor Baker, on plastic theory. He also worked on beam-columns and structural connections and from this work produced the E.I.C. paper, "The Design of Compressed Beams".

Before returning to Canada in 1954 he received the degree, Ph.D. He joined the staff of Queen's University shortly afterwards. Since that time he has engaged in consulting work, in the design of the first "plastic" building in North America, and in further research in bridges and plastic theory, while carrying on teaching duties.

The paper was published in the February issue of the *Engineering Journal.*

GZOWSKI MEDAL

The Gzowski Medal is awarded for the best paper of the medal year provided such paper shall be adjudged of sufficient merit as a contribution to the literature of the profession but not otherwise. It is a gold medal, provided from the fund established in 1889 by Colonel Sir Casimir Gzowski, A.D.C., K.C.M.G., late past-president of the Institute.

Winner for 1957 is the New York City builder of bridges on five continents, David Bernard Steinman, whose paper, "The Design of the Mackinac Bridge," appeared in the May issue of *The Engineering Journal.*

D. B. Steinman, M.E.I.C.

Born in Brooklyn, Dr. Steinman studied at the City College of New York, then won three scholarships to Columbia University, where he took A.M., C.E., and Ph.D. degrees. He was professor of civil engineering at the University of Idaho for four years, at the outset of his career, from 1910 to 1914, and professor of civil and mechanical engineering at the City College, New York, from 1917 to 1920. Since 1920 he has been in private practice and has served as designing or consulting engineer in the construction of more than 400 bridges on five continents. Eight of his bridges have been honoured in the annual awards for the most beautiful bridges in America. He has received numerous honours, both national and international, for distinguished achievements. He has twice received the Norman Medal, highest award of the American Society of Civil Engineers, in addition to two other awards of the Society.

He was the founder and first president of the National Society of Professional Engineers. Today it has a membership of 37,000.

Among the many notable bridges on which Dr. Steinman was designer or consultant are the Florianopolis Bridge in Brazil, the Mount Hope Bridge in Rhode Island, the St. Johns Bridge in Oregon, the Carquinez Straits Bridge in California, the Henry Hudson Bridge in New York, the Constitution Bridge in Puerto Rico, Thousand Islands International Bridge, the Bagdad Bridge over the Tigris River in Iraq, the Kingston Bridge across the Hudson River, the Raritan River Bridge in New Jersey, and the Connecticut Turnpike Bridge in New Haven. He is now engaged on plans for an international bridge between Sault Ste. Marie, Michigan, and Sault St. Marie, Ont., and another international suspension bridge over the St. Lawrence Seaway.

D. B. Steinman

D. T. Wright

He is the author of the biography, "The Builders of the Bridge," a number of standard works on bridge design and construction, and more than 600 technical papers and articles, many of them translated and published around the world.

In 1947 he was awarded an honorary doctor of science degree by his alma mater, and the University Medal for Excellence by Columbia University, followed by the Egleston Medal in 1951. He was presented with the highest award of the National Society of Professional Engineers in 1952. He has also, among many other awards, received a Doctor of Science degree at Columbia University and the University of Ghent, a Doctor of Civil Engineering, Bologna, Doctor of Engineering, Rensselaer Polytechnic Institute and Manhatten College, and Doctor of Laws, Alfred University.

In 1954 Dr. Steinman received the highest award of the Scientific Research Society, for his research and inventions in suspension bridge aerodynamics. He has been honoured as president, honorary member and fellow, of a long list of engineering and scientific societies. He is a Life Fellow of the Royal Society of Arts in Great Britain, and a past-president of the New York Academy of Sciences. He has been awarded the French Legion of Honour, the Grand Prix Humanitaire of Belgium, the Order of Merite Scientifique of France, the Memorial Cross of the Greek Legion, the Croix de Lorraine of France, and the Order of the Gold Cross of Rome, in addition to many other honours by foreign countries. For his work on the reconstruction of Brooklyn Bridge, he received a civil medal. He is presently engaged on the world's largest bridge project, the $100,000,000 Straits of Mackinac Bridge in Michigan. This year he received the Kimbrough Gold Medal, highest award of the American Institute of Steel Construction.

Dr. Steinman is the founder and president of the David B. Steinman Foundation for grants for education, for research and for student aid.

He is also recognized as a scientist, mathematician, inventor, educator, lecturer, author, artist, poet, and humanitarian.

W. R. Way

N. E. Hudak

LEONARD MEDAL

The Leonard Medal, awarded for papers on mining subjects submitted either to the Canadian Institute of Mining and Metallurgy or to the Engineering Institute of Canada, was presented to George Arthur Jewett, M.C.I.M., scheduling engineer with the Rio Tinto Management Service Company Limited, Toronto, for his paper, "Sampling Design and Grade Estimation of Mineral Deposits."

G. A. Jewett, M.C.I.M.

Mr. Jewett is a graduate of Queen's University, Kingston, Ont., class of 1948 in mining engineering. He later attended the Carnegie Technical Institute, Graduate School of Industrial Administration, Pittsburgh.

Mr. Jewett's professional experience includes work as a blast-hole engineer, and assistant planning engineer at the Helen Mine, Wawa, Ontario, from 1948 to 1951, and an assistant professorship. He held the appointment of assistant professor of mining engineering at Queen's University from 1952 to 1955.

Mr. Jewett is a Member of the Canadian Institute of Mining and Metallurgy and the Association of Professional Engineers of Ontario.

The paper was published in the March 1956 issue of *The Canadian Mining and Metallurgical Bulletin.*

THE ROSS MEDAL

The Ross Medal is awarded for papers on electrical engineering subjects. This year it has been awarded to William Russel Way, M.E.I.C. vice-president of the Shawinigan Water and Power Company, Montreal, for his paper entitled, "Growth and Development of Large Electric Power Systems." The paper appeared in the October issue of *The Engineering Journal.*

W. R. Way, M.E.I.C.

Mr. Way, now a director of Shawinigan Water and Power Company, the Shawinigan Engineering Company Limited and the St. Maurice Power Corporation received his engineering training at McGill University. Qualifying for the degree B.Sc. in electrical engineering in 1918 he joined the Shawinigan Water and Power Company as an assistant engineer, operating department, Montreal and successively worked in various divisions of the company including the protection division, metering division and the hydraulic test division. In 1924 he was transferred to Shawinigan Falls as chief system operator. Six years later he returned to head office Montreal to fill the offices of assistant superintendent of operations, and assistant general superintendent. Mr. Way was named general superintendent in 1944. In 1951 he became vice-president of generation and transmission. His president position dates to 1954.

G. A. Jewett (left)

Mr. Way has also been active in the affairs of the Canadian Electrical Association. He was a member of the Executive Committee of that organization for two years, from 1951-53. He is a member of the Corporation of Professional Engineers of Quebec.

JOHN GALBRAITH PRIZE

The John Galbraith prize is awarded for the best paper given by a Junior in the Province of Ontario. It has been won by Nicholas Edward Hudak, JR.E.I.C., supervisor, application engineer, of the Canadian Cutler-Hammer Limited, Toronto, for his paper, "Trends in the Design of Electrical Distribution for Industrial Plants."

The paper was published in the June issue of *The Engineering Journal.*

N. E. Hudak, JR.E.I.C.

N. E. Hudak, of Canadian-Cutler Hammer Limited, Toronto, graduated from the University of British Columbia in electrical engineering in 1948. He devoted the ensuing three years to the duties of instructor in electrical engineering while studying for a Master's degree. He joined the Canadian Westinghouse Company Limited, Hamilton, Ontario, in 1951, taking the graduate engineer training course and then spent three years as a switchgear design engineer. While associated with Canadian Westinghouse Limited, he lectured in a post-graduate course, "Symmetrical Components", given under the auspices of the Nova Scotia Technical College and took part in the E.I.C. Juniors and Students Papers Presentation. He was awarded the John Galbraith Prize for 1951-52 for a paper entitled "Location of Faults in Power Cables by Fault-Generated Surges".

In 1953 he accepted an appointment with the Amalgamated Electric Corporation Limited, Toronto, as a distribution equipment engineer. A year later he was appointed supervisor of application engineering, the position he now holds.

Mr. Hudak is an active member of the Canadian Army Milita and holds a Captain's commission in the Royal Canadian Electrical Mechanical Engineers.

Personals

News of the Personal Activities of Members of the Institute

J. Hoogstraten, M.E.I.C., formerly professor of civil engineering at the University of Manitoba has been appointed president of the Nova Scotial Technical College, following the retirement of Dr. A. E. Cameron.

Mr. Hoogstraten graduated from the University of Manitoba in 1929 with a B.Sc. degree and later qualified for an M.Sc. degree from the University of Michigan. Initially a lecturer and demonstrator in the faculty of engineering from 1930 to 1933, later professor at Brandon Collegiate, it was in 1936 that he joined the staff of the University of Manitoba.

Active in furthering the profession in the province, Professor Hoogstraten served six years on the Council of the Association of Professional Engineers of the Province of Manitoba, was president of that Association for the past two years. He was also Manitoba delegate to the Dominion Council for two years.

R. A. Dunn, M.E.I.C., general sales manager of the Canadian Liquid Air Company Limited recently elected a director of the company has been appointed vice-president in charge of sales.

Mr. Dunn, who is a metallurgist joined the company in 1939 as field engineer with the development and engineering department, and in 1947 was appointed general sales manager.

W. C. Heim, M.E.I.C., senior executive of Alchem Limited, Burlington, Ont., has been elected president and general manager of the firm. He has held the appointment of vice-president since 1955.

With the company throughout the length of his engineering career except for an initial two years following his U.B.C. graduation in 1942, Mr. Heim's first post with the firm was that of field service engineer with the industrial department. Since then he has held responsible posts as chief engineer, and later manager, railroad department. In 1953 the offices of assistant to the vice-president and also assistant general manager were taken over by Mr. Heim.

J. Hoogstraten, M.E.I.C.

W. C. Heim, M.E.I.C.

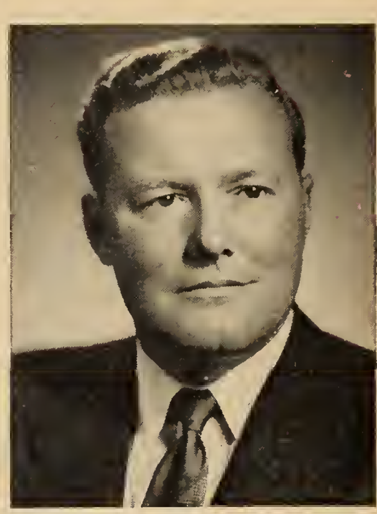
J. E. Leo Roy, M.E.I.C., chief engineer of the Quebec Hydro Commission's Auxiliary Services, has been appointed general manager of the Commission.

Mr. Roy was at one time associated with the Shawinigan Water and Power Company, and the Quebec Power Company in Quebec as assistant superintendent of the power division. In 1946 he accepted a position in the same capacity in Quebec Hydro's distribution department. In 1953 he was appointed to his present position.

Mr. Roy was the 1956 choice of president for the Corporation of Professional Engineers of Quebec. He is also chairman of the Montreal Branch of the Institute.

Louis O'Sullivan, M.E.I.C., assistant general manager of the Quebec Hydro-Electric Commission has been appointed a commissioner of the organization.

Mr. O'Sullivan became associated with the Montreal Light, Heat and Power Consolidated early in his engineering career, and in 1945 when the Hydro Commission took over the Montreal Light, Heat and Power properties was appointed to the newly created post of assistant general manager.



R. A. Dunn, M.E.I.C.

Mr. O'Sullivan was president of the Corporation of Professional Engineers of Quebec in 1952 and is also a former member of the Council of the Institute.

J. W. McCammon, M.E.I.C., general manager and commissioner of the Quebec Hydro-Electric Commission has retired from professional duties, following a career of forty-five years.

Mr. McCammon graduated from McGill University and gained a great deal of engineering and business experience with Mackenzie Mann and Company on the Mount Royal Tunnel, Montreal; as a manager of the pump and electrical departments of the Canadian Fairbanks Morse Company, Montreal and with the Charles Walmsley Company, Montreal, before joining the Beauharnois Light, Heat and Power Company in 1930 as assistant to the general manager. In 1945 he became general manager of the then newly established Quebec Hydro Electric Commission which took over the Montreal Light, Heat and Power Consolidated and the Beauharnois Light, Heat and Power Consolidated.

Dr. A. E. Cameron, M.E.I.C., president of the Nova Scotia Technical College since 1947, has retired after an engineering career of forty-three years.

Newly graduated from McGill University in 1914, with an M.Sc. degree in mining engineering, Dr. Cameron immediately gained experience with the Geological Survey of Canada in the Northwest Territories. He also worked with the Imperial Munitions Board, prior to serving in France and Belgium. At war's end returning to Canada he spent six years with the University of Alberta, mining and metallurgy department. In 1925 he received the degree of doctor of science in metallurgy from the Massachussetts Institute of Technology, returning to the former college as associate professor, and later professor of metallurgy.

Undertaking the duties of secretary of the Research Council of Alberta he carried out explorations in northern Alberta for the Council and engaged in private consulting work. Among the first to go into Great Bear Lake after the discovery of radium there, the first post office for mineral developments, Cameron Bay, N.Y.T., bore his name. In 1935 he ascended the South Nahanni River and explored the so-called Headless Valley and tropical valley of that area.

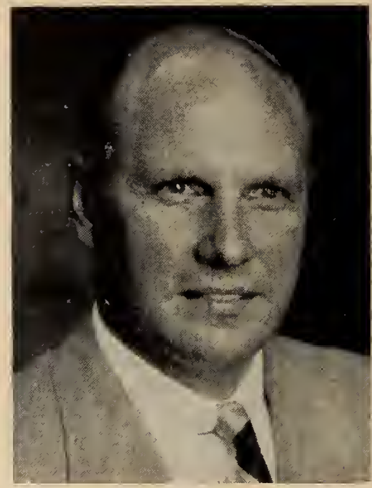
Named deputy minister for the Nova Scotia Department of Mines in 1937 Dr. Cameron carried on this work until chosen, ten years later, to fill the office he now relinquishes.

Dr. R. L. Hearn, M.E.I.C., has been elected a director of the Bridge and Tank Company of Canada Limited.

Dr. Hearn is a director of a number of Canadian companies including Atomic Energy of Canada Limited and the Canada Wire and Cable Company Limited.

W. D. Jewett, M.E.I.C., for a number of years export manager for the Dominion Bridge Company Limited at the firm's headquarters at Lachine, Que., has received the appointment of director of research. His new duties will entail work formerly carried out by the Company's industrial engineering department at the main plant in Montreal and by personnel in various branch plants of the organization.

W. D. Jewett, M.E.I.C.



D. B. Annan, M.E.I.C.

Mr. Jewett was earlier vice-president and general manager of the Canadian Overseas Projects Limited.

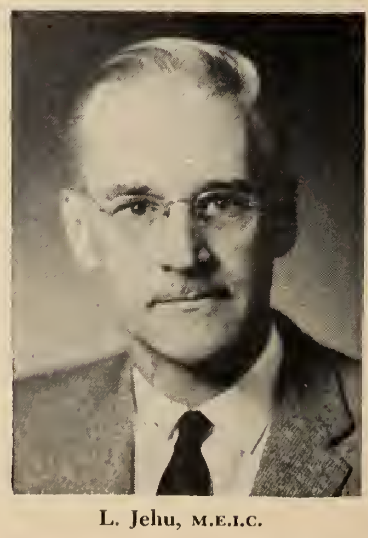
He is a graduate of the University of Toronto.

Llewellyn Jehu, M.E.I.C., has been promoted to welding and research engineer for the Dominion Bridge Company Limited, Eastern division.

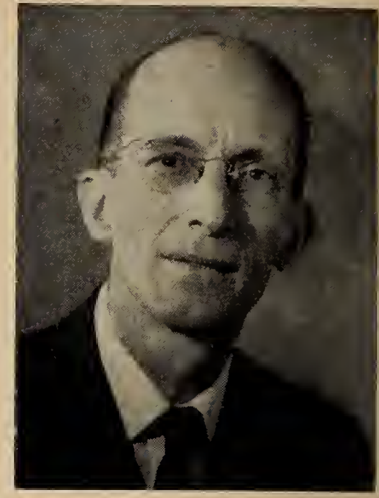
With the company for many years Mr. Jehu has served in numerous capacities including those of design engineer and assistant research and methods engineer.

R. J. Chambers, M.E.I.C., assistant chief engineer of the general engineering division of the Anglo Canadian Pulp and Paper Mills Limited and its associated mills, has been elected to the board of directors of the Dryden Paper Company Limited.

Mr. Chambers graduated from Queen's University, with a master's degree in mechanical engineering in 1935. At that time he became associated with the Gaspesia Sulphite Company Limited and remained there until 1946. Moving to Quebec he was named assistant chief engineer with the general engineering group of the Anglo organization.



L. Jehu, M.E.I.C.



P. N. Bland, M.E.I.C.

Professor William Bruce, M.E.I.C., has become chairman of the department of mechanical engineering at McGill University.

Professor Bruce was early in 1954 promoted from associate professor to professor of mechanical engineering at the University.

From Falkirk, Scotland, and a graduate of the University of Toronto, Professor Bruce joined the staff of McGill University in 1946 as an assistant professor.

D. B. Annan, M.E.I.C., plant engineer with the Norton Company of Canada Limited at Hamilton, Ont., was elected chairman of the Hamilton Branch of the Institute for 1957-58.

A native of the city in which he is now resident, and a graduate of Queen's University, class of 1940, Mr. Annan began his engineering career with the R.C.A.F. Returning to civil life in 1945 he joined the Canadian Westinghouse Company Limited at Hamilton as a metallurgist with the materials and process group.

P. N. Bland, M.E.I.C., chief engineer with the Canadian Sumner Iron Work Limited, is chairman of the Vancouver Branch of the Institute.

He attended the Vancouver Technical School and entered the employ of his present firm as an engineering student.

For the next ten years he carried out engineering duties with the firm in Washington as a draughtsman, and in Vancouver as a machine designer. In 1930 he accepted the appointment of assistant to the construction engineer with the Vancouver Kraft Company at Port Mellon, B.C. Over the next four-

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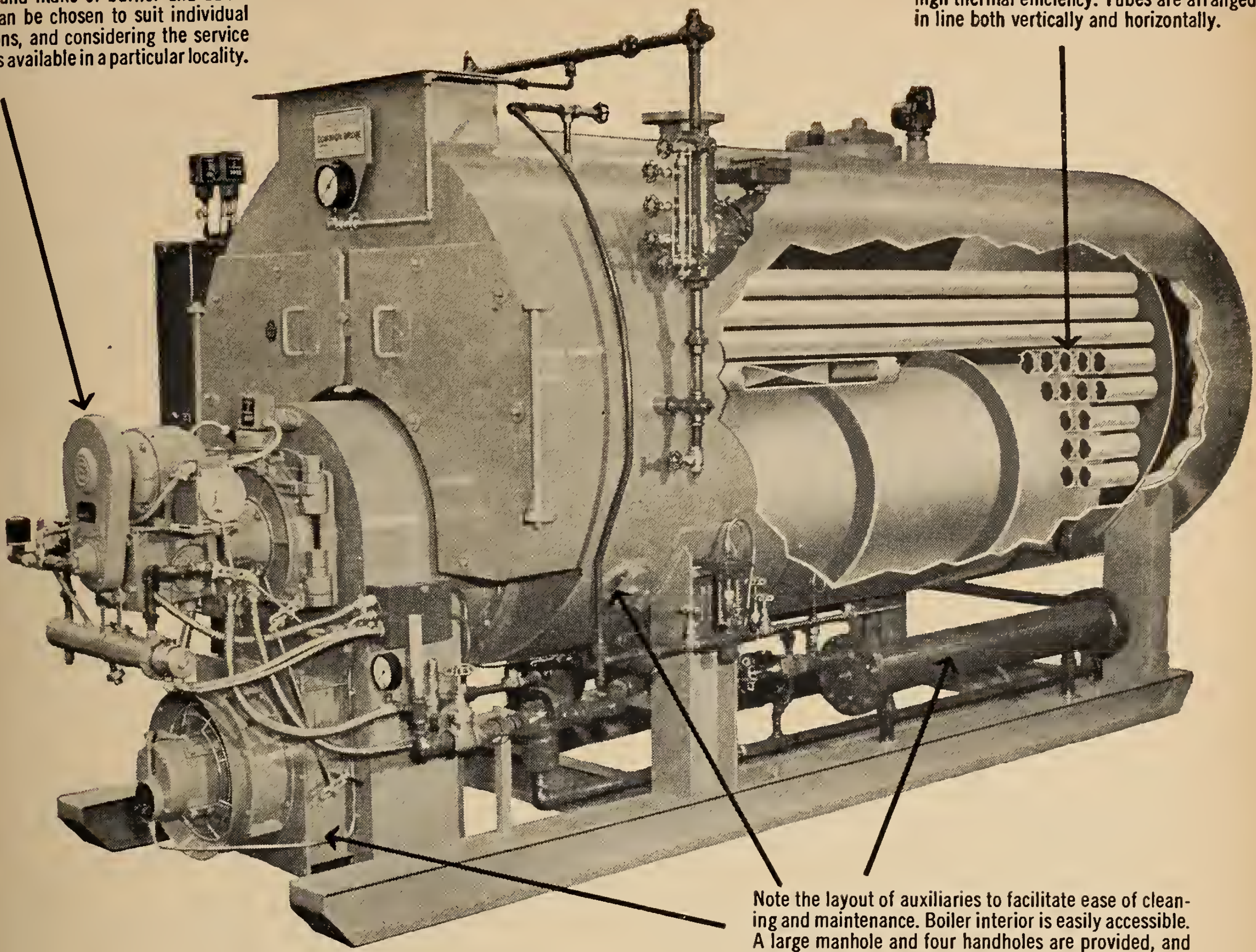
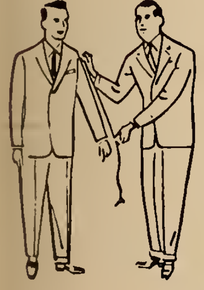


Note the layout of auxiliaries to facilitate ease of cleaning and maintenance. Boiler interior is easily accessible. A large manhole and four handholes are provided, and an access door to rear combustion chamber.

A custom-tailored package unit...



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...by Dominion Bridge

teen years, he was again employed by the Canadian Sumner Iron Works Limited, becoming chief engineer in 1937. He accepted an appointment as project engineer with the B.C. Pulp and Paper Company in 1946 and remained in this work for three years.

Mr. Bland has served on the executive of the B.C. Chapter of the American Society of Metals; was a Member of the Board of Examiners of the Association of Professional Engineers of B.C. from 1948 to 1952 and has lent his assistance to that organization as a Member of Council.

E. P. Innes, M.E.I.C., chief engineer of the Canadian Canners Limited, Hamilton, Ont., has been elected a director of Canners Machinery Limited, at Simcoe, Ont.

Mr. Innes, who joined the firm many years ago is a graduate of McGill University.

Gordon Cape, M.E.I.C., of the Dominion Bridge Company Limited, Lachine, Que., has been named for the post of manager of technical research. Mr. Cape formerly served as welding and research engineer in charge of the industrial engineering department.

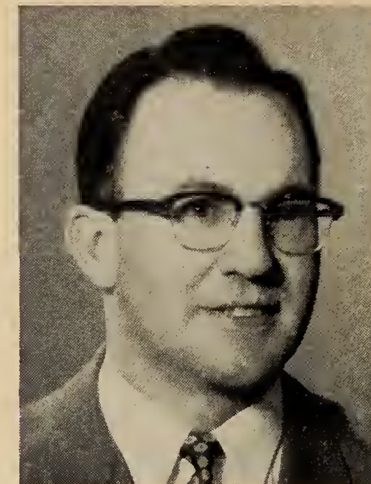
He was earlier in his career chief inspector with the firm, and is a graduate of McGill Univeristy.

J. C. Dale, M.E.I.C., president and general manager of Canadian Utilities Limited, Edmonton, has been elected president of the Canadian Electrical Association.

Mr. Dale has been a vice-president of the Association since 1954, chairman of several engineering sections, and a member of the executive committee since 1953.

W. G. McKay, M.E.I.C., associated with the firm of Underwood, McLellan

W. G. Small, M.E.I.C.



R. D. Rosser, M.E.I.C.

and Associates Limited, of Saskatoon, has beeen elected chairman of the Saskatchewan Branch of the Institute.

A 1940 graduate of Queen's University in civil engineering Mr. McKay joined his present firm in 1945 as an assistant engineer on the design of water supply and sewage disposal systems. Prior to that he held an appointment as senior sanitary engineer with the Department of National Health and Welfare at Edmonton. The post involved Saskatchewan, Alberta, Northern B.C. and the N.Y.T. At the outset of his career he was employed as a demonstrator on concrete, steel and timer design at Queen's University.

R. H. Tivy, M.E.I.C., formerly regional transportation engineer at Moncton, N.B., with the Canadian National Railway has been named to the post of assistant superintendent of the New Glasgow division of the organization.

Mr. Tivy also served the C.N.R. as assistant engineer in the department of research and development, shortly after joining the firm in 1953.

A 1943 graduate of the University of Manitoba in electrical engineering, Mr. Tivy has also been with the Manitoba Power Commission at St. Boniface, Man., as electrical engineer.

R. D. Rosser, M.E.I.C., of Brown Boveri (Canada) Limited was recently appointed Alberta Branch manager of the organization, located at Edmonton.

Mr. Rosser is a graduate of the University of Alberta, class of 1949, in electrical engineering.

Mr. Rosser joined the company in 1953 following four years' service with the Canadian Westinghouse Company Limited and then served as sales engineer of the Brown Boveri Calgary office.

J. L. Bryant, M.E.I.C., of Ross Engineering of Canada Limited, has been appointed chief engineer with headquarters at Montreal. In his new position Mr. Bryant will be responsible for the en-

G. Cape, M.E.I.C.

W. G. McKay, M.E.I.C.

gineering, research and development departments of the company.

Mr. Bryant obtained his bachelor's degree in mechanical engineering from the University of British Columbia, class of 1945. He has been employed by Ross Engineering of Canada Limited since 1947 and was appointed manager of the company's Vancouver office in 1951.

W. G. Small, M.E.I.C., newly elected chairman of the Kootenay Branch of the Institute holds the appointment of supervisor of the instrument section with the Canadian Mining and Smelting Company of Canada Limited at Trail, B.C.

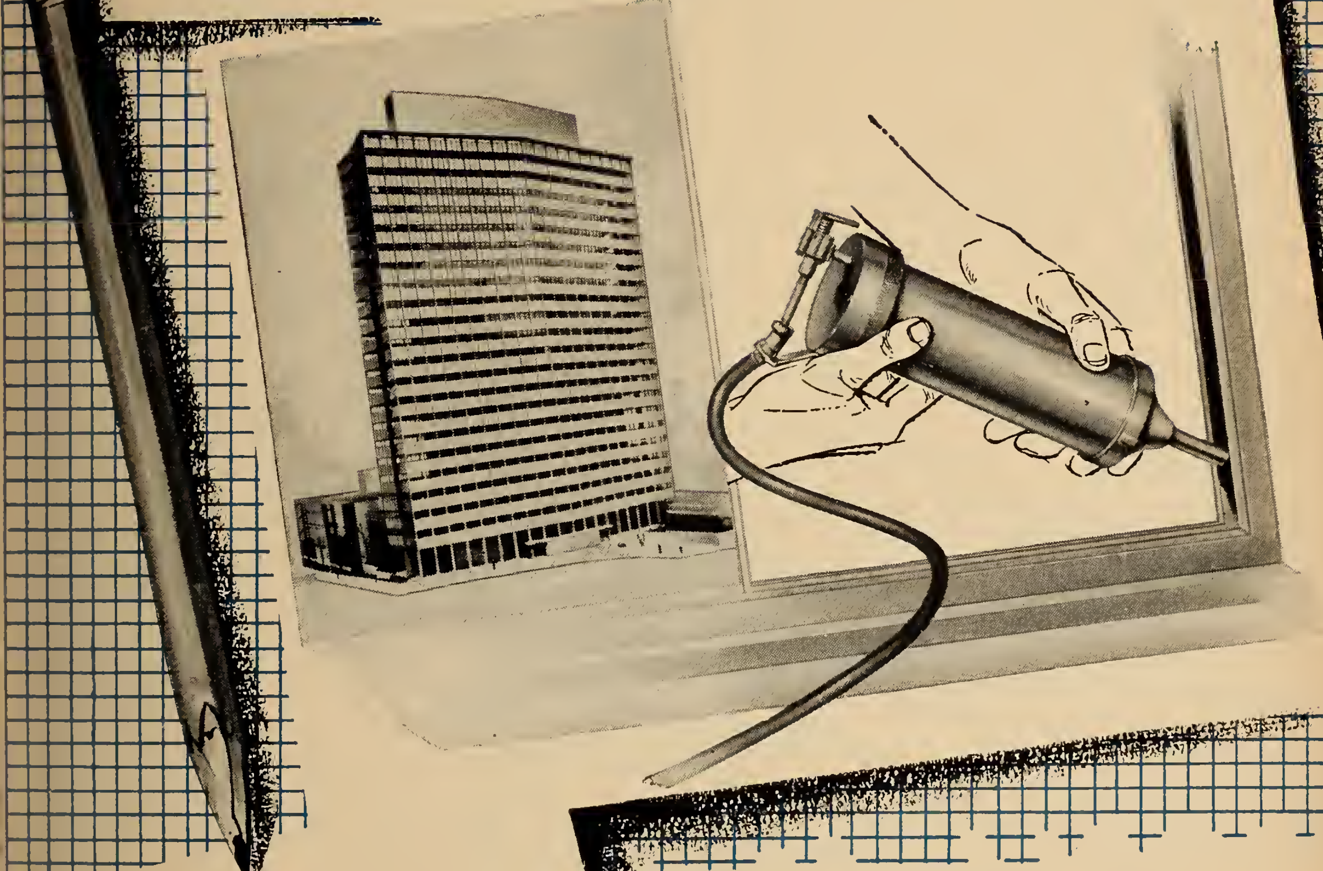
Originally from the prairie provinces

CORRECTION

In the June issue of the Engineering Journal, in the section, "Newly Elected Officers of the Institute", it was reported that W. J. Ripley, M.E.I.C., holds the office of vice-president, Ontario, of the Pineland Timber Company Limited, Sudbury, as well as that of economic consultant for the firm. Mr. Ripley holds only the latter affiliations with the company. The Journal greatly regrets th error.

Problem:

North Western Supply Company, of Vancouver, needed a sealing compound to form a perfect and permanent seal between glass and aluminum in curtain wall construction. It had to remain flexible at temperatures which cause varying expansion, to resist weather and allow constant movement between surfaces without deterioration.



Solution:

Polysar Butyl 301 proved to be the answer to North Western's exacting sealing problem. As the base for Norwescoseal 566, Polysar Butyl 301 imparts the essential qualities of permanent adherence in all weather between the sealing compound and materials of varying physical qualities under repeated flexing.

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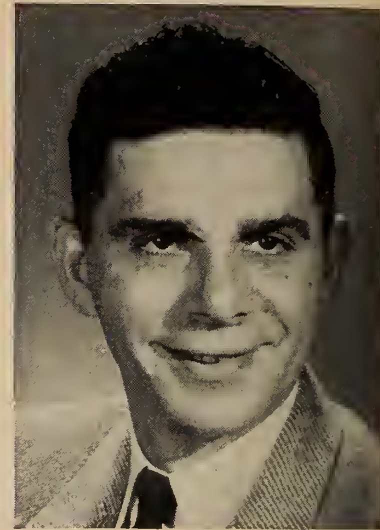
educated in rural Manitoba and at the University of Saskatchewan, Mr. Small became established in Trail in 1928, four years after his graduation in civil engineering. His initial experience as a draughtsman gained with the Canadian Pacific Railway and other companies, he became design draughtsman for the Canadian Mining and Smelting Company on structural steel and re-inforced concrete design, and later technical librarian in the chemical and fertilizer department. He was in 1936 named a research assistant in that department, working on ammonia synthesis, and the design and operation of various types of equipment. Through the years engaged in the work of instrument engineer, in supervising, and in the maintenance of the instrument department, some of his more recent appointments were concerned with application engineering and instrument development.

B. Justewicz, M.E.I.C., originally of the University of Warsaw who resumed his studies after the war and graduated from the University of Louvain, Belgium, class of 1949, now holds a position with the Bell Telephone Company of Canada, toll area engineering, as project engineer in the microwave and radio department, at Montreal.



W. Bobbie, JR.E.I.C.

At the outset of his career associated with the general design and estimate of waste gas heat exchangers for industrial power plants and furnaces applications, he later became a project engineer with consulting offices at Brussels and Paris.

Since his arrival in Canada in 1953 he has held various positions with the Bell Telephone Company prior to his present appointment.

J. A. M. Bell, JR.E.I.C., of Canadian Industries Limited formerly technical service representative for the Vancouver district of the organization has been transferred to the head office of the technical service section, explosives division in Montreal.

William Bobbie, JR.E.I.C., has been appointed plant engineer with the B. F. Goodrich Canada Limited at Kitchener, Ont.

Mr. Bobbie, a graduate of the University of Toronto in mechanical engineering has served as industrial engineer in the Kitchener plant for the past year.

Prior to that he was associated with Dunlop Canada Limited at Whitby, Ont., as a plant engineer.

Alex C. de Lery, JR.E.I.C., has been appointed manager of the Montreal office of the English Electric Company of Canada and the John Inglis Company. Mr deLery joined the English Electric Company in 1951 and represented the company in Quebec for five years. He moved to Montreal in 1956. Mr. deLery graduated from the Seminaire de Quebec with a degree of B.A. in 1943 and later in 1948 received a B.A.Sc. degree from Laval University.

J. Blouin, JR.E.I.C., formerly of the firm of H. J. O'Connell Limited, Schefferville, P.Q., is now associated with the Iron Ore Company of Canada at that

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Herbert J. Holtom

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address. In his former position he was engaged in the construction of a Mid-Canada Line radar station.

As electrical field supervisor with the Iron Ore Company, Mr. Blouin is responsible for all the electrical maintenance of the equipment used in the mines.

A. G. Eliadis, JR.E.I.C., of McColl Frontenac Oil Company Limited has been promoted to the position of chief design engineer.

Following graduation from McGill University in civil engineering in 1951, where he received a B.Eng. degree, Mr. Eliadis began his professional career with the Canadian International Paper Company. He accepted employment with his present firm in 1953 as a structural and foundation engineer.

J. L. Greer, JR.E.I.C., is one of the executive officers of the recently incorporated company of W. L. Wardrop and Associates (management) Limited, engineering consultants at Winnipeg. He is also a director of the firm.

Now in its third year of operation Mr. Greer joined the organization some time ago.

Mr. Greer is a graduate of the University of Saskatchewan, class of 1948. He

J. A. A. Field, S.E.I.C.

gained his early experience with the Foundation Company of Canada Limited.

E. J. Beauchamp, JR.E.I.C., has resigned from his position with Underwood, McLellan, of Saskatoon, Sask., and has accepted a position with the City of Toronto buildings department.

Mr. Beauchamp graduated from the University of Sakatchewan in civil engineering in 1955 and went to work for the Department of Highways, Province of Saskatchewan for a short period.

R. M. Williamson, JR.E.I.C., formerly of the Demerara Bauxite Company Limited at MacKenzie, British Guiana, has joined the engineering staff of Dupont of Canada at their Nylon Intermediate Plant, Maitland, Ont.

Mr. Williamson is a 1954 graduate of Queen's University in mechanical engineering.

F/O F. R. Jefferson, S.E.I.C., a 1957 graduate of the Nova Scotia Technical College in chemical engineering is with the Canadian Armed Forces in Europe where he is Squadron Armament Officer for 441 Fighter Squadron (Sabre Aircraft), R.C.A.F.

R. R. Real, JR.E.I.C., a University of Saskatchewan graduate in electrical engineering, class of 1953, is newly employed as an associate research officer with the radar development section of the radio and electrical engineering division of the National Research Council.

Mr. Real was this year awarded a master of engineering degree at McGill University.

James A. A. Field, S.E.I.C., of Regina, Sask., was one of two winners of the Association of Professional Engineers (Sask.) prize for the most distinguished graduate in engineering at the forty-sixth annual convocation of the University of Saskatchewan in Saskatoon. Mr. Field received the degree of bachelor of science in engineering (electrical) B.E., also with great distinction.

NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

CORNER BROOK

ERIC R. SKANES, JR.E.I.C.,
Secretary

Year in Review

First meeting of the year was held on March 4. President F. H. Clark held the chair and fifteen members and ten guests were present.

On loan from the Dow Corning Company a film on Dow Silicones was shown and literature on Dow Silicones was distributed to those present. Interesting and instructive, the film was enjoyed by all.

A nominating committee consisting of E. J. Leja, M. G. Green and R. Herdman was appointed and instructed to present a slate of officers for the coming year, at a meeting called for April 9. Film Shown. Opening that meeting, April 9, the film, "Newfoundland Enterprise" was shown and very much enjoyed by the group. It dealt with Bowaters Newfoundland Pulp and Paper Mill Ltd., and Newfoundland operations. *Election of officers.* Nominations of prospective officers for 1957 were submitted by the nominating committee. In the ensuing election the following were elected: to the presidency, M. G. Green; vice-chairman, E. J. Leja; secretary, E. R. Skanes; and treasurer, W. S. Read.

The following chairmen were appointed by the new president: program chairman, H. B.Carter; social, membership and publicity chairmen; Robert Herdman, Allan Staig, and W. R. Hughson respectively.

Before relinquishing the chair, president F. H. Clark presented a small gift to W. R. Hughson on the event of his election to life membership in the Institute. The newly elected president, M. G. Green, thanked members in their selection of him as president and promised an all-out effort on his part and his officers during the coming year. Guest at the meeting was G. W. Ross, of Canadian General Electric Company, Sydney, N.S. In the ensuing discussions, it was moved and seconded that meetings be held on the second Tuesday of the month and an executive meeting on the third Tuesday of each month.

Banquet and Dance in May

On Tuesday evening, May 14, the Branch held a banquet and dance at the Blomidon Country Club and Milton G. Green, Branch president, in his speech welcomed the ninety people present. A cocktail hour was followed by an excellent three-course dinner served by caterers of the club. Henry B. Carter then introduced guest speaker Allan Staig, municipal engineer. Mr. Staig dealt with the history of engineering and evolution of the engineering societies. He also gave an outline of road-building problems in Corner Brook. A vote of thanks was offered Mr. Staig by Wally Read at the conclusion of his address. The ladies were toasted by Robert Herdman.

Starting off with a "Rabbit Dance", the evening offered dancing provided by Herb Collins and his orchestra. Other novelty dances included a broom dance, won by Mrs. Robert Hardman and Ray Stones of the Montreal office of Bowaters. Winners of the elimination dance were Mr. and Mrs. Allan Curnew. Other entertainment came from Henry Carter who sang Newfoundland songs. Wally Read conducted a sing-song. Mr. Herdman was master of ceremonies.

The June Meeting

A very successful meet was held June 11 in the White House. Twenty-seven members and eighteen guests took part. The press was also represented. A very short business meeting was held in which the president announced that guest speakers were being arranged from the Canadian General Electric Company and the Canadian Wildlife Service of the Department of Northern Affairs and National Resources. A speaker from Montreal, would also discuss Atomic Energy. Further business was the ratification of the appointment of Henry B. Carter as Branch representative of the nominating committee.

Important Film Shown. Main portion of the meeting was taken up with the much enjoyed showing of the film, "Leonarndo da Vinci". Coffee and sandwiches and a short executive meeting followed the event. Final arrangements were made to have the film shown free of charge at Corner Brook's two high schools. Hubert Clark and Henry Carter agreed to introduce the film at the schools and tell the students a little about the engineering profession.

KINGSTON

D. I. OUROM, JR.E.I.C.,
Secretary-treasurer

Annual Meeting

The annual meeting of the Kingston Branch was held June 8, 1957 at the R.C.E.M.E. officers' mess.

Elections and appointments were as follows: chairman, C. W. Jones; vice-chairman, E. C. Reid. The executive are comprised of J. W. Dolphin, S. D. Lash and W. B. Rice. Mr. Dolphin assumed the duties of vice-chairman in March on the resignation of Mr. Reid on his transfer to Montreal. The immediate past-chairman is A. V. Corlett. Kingston Branch councillor is H. G. Conn and the secretary-treasurer is D. I. Ourom.

Six executive meetings and nine meetings of the Branch were held during the year as follows: "Some Notes on Terrorism" by C. D. Quilliam; "Iron Ore by '54", by J. A. Little; a Joint E.I.C.-P.Eng. Meeting and "the Ontario Joint Highway Research Program at Queen's University", by S. D. Lash, all in the fall of 1956. Beginning in January and drawing to a close in mid-April was a talk on "Guided Missiles", the President's dinner, and the Students' Papers Night, as well as a talk on Metal Cutting Research, by W. B. Rice; a Joint C.I.C., K.M.S., and E.I.C. dance and an address by R. F. Legget, and E. G. Swenson on "Concrete Problems in the Kingston Area".

KOOTENAY

G. T. J. HUGHES, M.E.I.C.,
Branch News Editor

Turbine Specialist Speaks

Members of the Institute of Power Engineers gathered with the Branch to hear D. F. Abel, Calgary district turbine specialist of the Canadian General Electric Company speak on the installation of the Gas Turbines for the B.C. Power Commission at Chemainus on Vancouver Island on May 13. A total of 50 guests members and visitors attended.

After an introduction by Doug. Turland of Canadian General Electric, Mr Abel described the location of the fou

large gas turbines at Chemainus. This station, designed by Sandwell and Co. of Vancouver, when operating, would be the largest gas turbine installation and would house the largest single shaft gas turbines in the world. An interesting point was that a tanker of Bunker C fuel would be used every two weeks.

To Serve Until Hydro Power Available—The B.C. Power Commission's intention was to build a plant which would meet power requirements until Hydro-electric power was available. When new hydro stations were built, the gas turbine installation at Chemainus would be relegated to stand-by duty, or peak duty, or would be put into service during periods of low water.

The equipment consisted of two simple cycle units and two regenerative cycle single shaft units. The regenerative cycle units were preferable because of their comparatively high thermal efficiency, while the reason for including the simple cycle units was because they were already designed and in production and their delivery assured in a much shorter time.

Mr. Abel described in detail the functioning of the units and dealt comprehensively with the control system, noting that the power output was directly proportional to the temperature of the gases entering the turbine. A device for controlling the amount of fuel after starting by a separate motor, consisted of solenoid valves which became energized when the unit reached 20 percent speed and admitted enough fuel to fire the unit. As the unit fired the valve reduced the fuel supply to warm-up flow. The same valve, when the unit reached a speed of 40 per cent, increased the fuel supply to accelerate the unit to full speed. A further solenoid operated as a maximum fuel limiting device.

The lubrication was similar to that used in ordinary steam turbine practice.

Fuel Oil Treating System Interesting—An interesting feature was the fuel oil treating system. Since Bunker C oil, a low-grade oil, contains metallic salts mainly of sodium and vanadium which attack the buckets and nozzles of the turbine, it was necessary to ensure that a rigid specification of the fuel must be met. This was provided for by the installation of a fuel-oil treating system. The process consisted of washing to remove the sodium and adding magnesium sulphate to neutralize the vanadium. A further refinement was the injection of a compound, a waste product of catalyst cracking plants, which was a very good abrasive that cleaned the buckets and restored the nozzle area.

Mr. Abel concluded his talk with an invitation to inspect the station, and remarked that the first unit was now being installed and it was hoped that the station would be in operation late this year.

Later, at a business meeting, a motion was approved amending the Kootenay Branch Award—a $50.00 Scholarship to the student in Grade XIII in Trail, Castlegar or Nelson with the highest total marks in physics, chemistry and mathematics in their final examinations, and who is continuing his studies at a recognized university. The successful candidate should not have received a prior award in excess of $500.00. The previous condition had been set at $100.00.

SASKATCHEWAN

R. BING-WO, M.E.I.C.,
Secretary-treasurer

P. D. Course at Saskatoon

Professional Development courses were held in Saskatoon in 1952 and 1953. Sponsored by the Saskatoon Section, they were operated by the Extension Department of the University of Saskatchewan. The latter was sponsored and operated by the Saskatoon Section.

• BRANCH NEWS

In September 1955, W. G. McKay, then vice-chairman of the Saskatchewan Branch set up a committee to organize a Professional Development Course for Saskatoon engineers. Committee members were Mel Jones, chairman, Stu Ringheim, Sid Warder, Gus Handegord, and John Mantle.

Fifty registrations among M.E.I.C. and Jr.E.I.C., and 16 S.E.I.C. registrations were taken. The fee was $250 for students and $5.00 for others. Attendance averaged 42 persons.

Covering a wide variety of topics, the program, extending from January to mid-March was as follows—"How to Run a Meeting", by Dr. D. Gibson, of the University of Saskatchewan; "Photography and Its Uses to the Engineer" by B. D. Leddy, of the National Research Council; "Soviet Professional Manpower" by Prof. L. E. Gads of the University of Alberta, at a joint meeting with the Association of Professional Engineers of Saskatchewan; and "Corporate and Financial Organization" — Managerial Controls, delivered by H. Pinder of Pinder's Drugs, Saskatoon.

In February, "Investment Policy for the Individual", by R. E. Forrest of James Richardson and Sons; "Report Writing", by Dr. J. D. Mollard, of J. D. Mollard and Associates, "Cost Estimating", by A. Tubby of H. J. Tubby and Son Limited, and "Selection and Evaluation of Employees", by C. McLeod, of the City of Saskatoon were discussed.

During the final month of the course Mr. N. Agnew of the University Hospital, Saskatoon was heard on "Psychology and Engineering"; W. R. Riddell, Saskatchewan Power Corporation spoke on "Employer-Employee Relations" and finally at a mixed dinner meeting on March 18, the closing address was delivered by Prof. Kay Taggert, of the Home Economics Department of the University of Saskatchewan on the topic of "Good Manners are Good Business" at a mixed dinner meeting.

It has been recommended that a Professional Development Course be operated again next winter and that it be confined to a narrower subject range. Possibilities include a course on legal topics, in conjunction with the local Bar Association, or a Toastmaster's Club in conjunction with some other professional group in Saskatoon.

NIAGARA PENINSULA

P. A. SALDAT, JR.E.I.C.,
Secretary

B. H. CHICK, JR.E.I.C.,
Branch News Editor

Talk on Circuit Breakers

A dinner meeting was held on Thursday, April 25, 1957, at the Rainbow Inn,

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• BRANCH NEWS

St. Catharines, Ont. Guest speaker of the evening, T. R. H. Jenkins of the English Electric Company gave a talk illustrated with slides and a film, on recent developments in circuit breakers. Demonstration models of low-voltage circuit breakers were also shown. Two staff members from the English Electric Company accompanied Mr. Jenkins and spoke on circuit breaker design and development.

On Thursday, May 30, 1957, the Branch held its annual dinner meeting and ladies' night at the refectory, Niagara Falls, Ont.

D. A. Barnum of Niagara Falls introduced the guest speaker, V. E. F. Solman of the wildlife division of the Department of Northern Affairs and Natural Resources. Mr. Solman's address, entitled, "Wildlife of Canada", was illustrated with colour slides and movies. The speaker outlined the scope of the work undertaken by his section and explained that a staff of thirty-four biologists were responsible for the area bounded on the west by the Pacific Ocean, to the Atlantic Ocean on the east, and from Point Pelee in Lake Erie to a point 450 miles from the North Pole on Elsmere Island.

During the business portion of the meeting, annual reports were presented by P. A. Saldat, secretary-treasurer; P. L. Climo, Branch chairman; P. Buss, councillor, and H. J. Saaltink, chairman of the Professional Development group. Mr. Climo turned the meeting over to E. C. Little, of Fonthill, who was named chairman of the Branch for 1957-58.

Results of recent ballotting were announced and the following were named to the executive for the coming year; E. C. Little, chairman; D. A. Barnum, Niagara Falls, vice-chairman; M. Stevenson, secretary-treasurer; P. Buss, Thorold, councillor; P. L. Climo, St. Catharines, past-chairman; H. J. Saaltink, and G. N. Cotton, both of Niagara Falls; H. C. L. Joe, D. O. Ramsdale, and D. D. Tanner, of St. Catharines; G. E. Griffiths, Thorold; and C. A. MacDonald, of Fort Erie.

NIAGARA GROUP

4th Annual Engineers' Dance To Be Held Friday, September 27.

The Niagara Branch of the Engineering Institute of Canada in conjunction with the Professional Engineers of Ontario is completing arrangements for their Annual Ball on Friday, September 27.

The dinner and dance will be held at Prudhomme's Garden Centre Hotel, Vineland, Ont. at 6:15 p.m. Dinner will be served at 7 p.m. and the dance will follow. Music will be supplied by Mart Kenny and his Western Gentlemen. Dress is optional and tickets are $10.00 per couple.

E.I.C. Committee members are: Chairman—Sami Tibshiram, Bruce H. Chick, and R. D. MacKinnie.

TORONTO

D. S. MOYER, JR.E.I.C.,
Secretary-treasurer

A. C. DAVIDSON, M.E.I.C.,
Branch News Editor

Jet Streams and Forecasts

"Through Jet Streams to Longer Range Forecasts" was the topic presented to the Toronto Branch by Dr. D. P. McIntyre, chief of the research and training division, Meterological Branch, Department of Transport, on April 11, 1957. Dr. McIntyre traced the history of meteorology briefly. It all began about 2300

years ago, and reference to the science may be found in Aristotle's works. Modern development began with instruments which showed the changes in temperature and pressure. With the coming of the telegraph, expansion was rapid. The radiosonde or sounding balloon which is used to provide information about the upper atmosphere has caused an even more rapid expansion. Today the field of meteorology is dividing into specialties as numerous as those in any other field of science generally.

Before discussing the jet stream itself, Dr. McIntyre reviewed two fundamental physical principles. The effect of the Corioli force must be accounted for in the atmosphere, that is to say that any particle moving eastward on the surface of the earth also tends to deviate toward the equator. An isobaric surface (surface of equal pressure) will slope more the higher one goes, and the wind will increase with height in the direction in which one faces.

Research in Canada now shows that the present model of the earth's atmosphere can be best approximated by a three front-four air mass system. There is reason to believe that this system will have to be replaced by a four front-five air mass system soon. At a front in this model there always exists an abrupt temperature drop when progressing from south to north; and at a height of about 20,000 feet the wind blows steadily from the west.

Discovered by Electronic Sounding. The jet stream was first discovered by electronic sounding. It appears at the junction of the lower atmosphere (troposphere) and the stratosphere where the weight of the atmosphere above equals that below. It is always associated with a front. This fact is, by the way, a Canadian discovery. These jet streams mark the boundary between two air masses and tend to form in the northern latitudes moving to the south at intervals of about 20° in latitude. The jet stream is about 18 or 2,000 feet in the air, so that it is not easily detectible from the ground. However, it governs the weather beneath it. An ordinary cyclone or low pressure area will form at ground level and move along the earth's surface in the direction of the jet stream, so that it is now possible to forecast approximately five days in advance what the weather will be, if the direction of the jet stream and its position are known for the particular locality.

Phenomena Illustrated by Slides. Dr. McIntyre illustrated his talk with slides which showed the phenomena associated with the jet stream very clearly, particularly the formation of waves in the upper atmosphere which move from west to east. These waves have a half-wave length which is continent-wide. The ordinary cyclone tends to form in the trough and move toward the ridge, giving rise to the weather on the earth's surface. What causes the cyclone or low to form is still a mystery, but research will discover the reason sooner or later.

In the question period which followed Dr. McIntyre explained how the 30-day weather forecast is compiled, using the jet stream theory. He emphasized that this method was much better than averaging climatological data and considering the probability of the event occurring again.

Arrangements for the meeting were under the direction of E. R. Davis, Branch chairman. Thanks of the members was tendered by D. G. Abbey.

Deep Water Cable Laying

Eighty members of the Toronto Branch heard N. R. Spencer, staff electrical engineer of the Canada Wire and Cable Co. Ltd. deliver an interesting talk on "Field Problems in Deep Water Cable Laying" on May 2, 1957.

Mr. Spencer began by describing basic problems involved in a cable laying operation. The principal concern is to convey the cable to the sea-bed without damage and without forming loops which might cause trouble later. Laying can be done in several ways, by using cable ships, sea-going barges or the cable can be floated across if the gap is narrow. The cable ship is of course specially equipped with cable brakes, tensioning equipment for controlling the tension in the cable as it is paid out, sonar and an active rudder for accurate steering to insure that the cable is properly laid on the sea bed horizontally as well as vertically. The barge method is very economical, particularly when the railway cars carrying the cable can be loaded directly on it.

Specially Constructed Cable. The cable itself is of special construction. The conductors are insulated with a paper-jute wrapping system or more recently with polyethylene, and polyvinylchloride, jute wrappings. An armor sheath of steel wire is laid on to protect the conductors from damage, and to take the tension of the cable laying process. The armor, while giving the necessary protection, adds a complication in that losses in the power transmitted are caused by induction.

The geographical position of the cable on the seabed is determined by the positions of the transmitting and receiving load centres the shape of the sea-bed it-

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Member: A. V. Roe Canada Limited and The Hawker Siddeley Group self in the vertical plane, currents, tides, and the hazards of anchoring. The dead weight of the cable-depth of water and speed of the laying vessel all affect the tension. The tension in the cable at the vessel cause the armour to untwist, elongating the insulation and the conductors themselves. This slackening at the surface causes tightening further down, and the tension is transferred to the conductors and the material insulating them.

Splicing a Necessity. Splicing is often necessary since the length of cable which can be transported on land is limited by the size of the transport. The best place to splice is on land. This can be done on the dock where the laying vessel is berthed before the cable is put on board, or the whole operation can be done at the factory and the cable coiled in the train, car by car.

The laying of the cable must be done with care and accuracy so that the width of sea-bed occupied is as narrow as possible to minimize the hazard from dragging anchors.

At the shore ends, the cable is protected by extra armour, since the cable can be abraded severely by ice or by the tidal movement. The extra armour on the shore end is also helped by burying the cable in a trench or by covering it with gravel.

Film Shows Cable Laying in B.C. Mr. Spencer illustrated all the salient points described with slides, and a film which showed the laying of a cable 4 miles long between the mainland of British Columbia and Texada Island. At some points the cable was at a depth of 1100 feet below the surface. The film was made by P. J. Croft, a member of the Toronto Branch executive who also made the meeting arrangements. A hearty vote of thanks was moved by Tom Dembie. The meeting was chaired by Dunc. Whitson, a branch councillor.

VANCOUVER

J. J. KALLER, M.E.I.C.,
Publicity chairman

A. D. CRONK, JR.E.I.C.,
Secretary

Election of Officers

As a result of the election of officers for the Vancouver Branch the following members comprise the executive for the 1957-58 season. Chosen as chairman of the group was P. N. Bland, replacing S. S. Lefeaux, retiring chairman. Elected vice-chairman was W. G. Heslop. The offices of secretary and treasurer went to A. D. Cook and R. H. Carswell respectively.

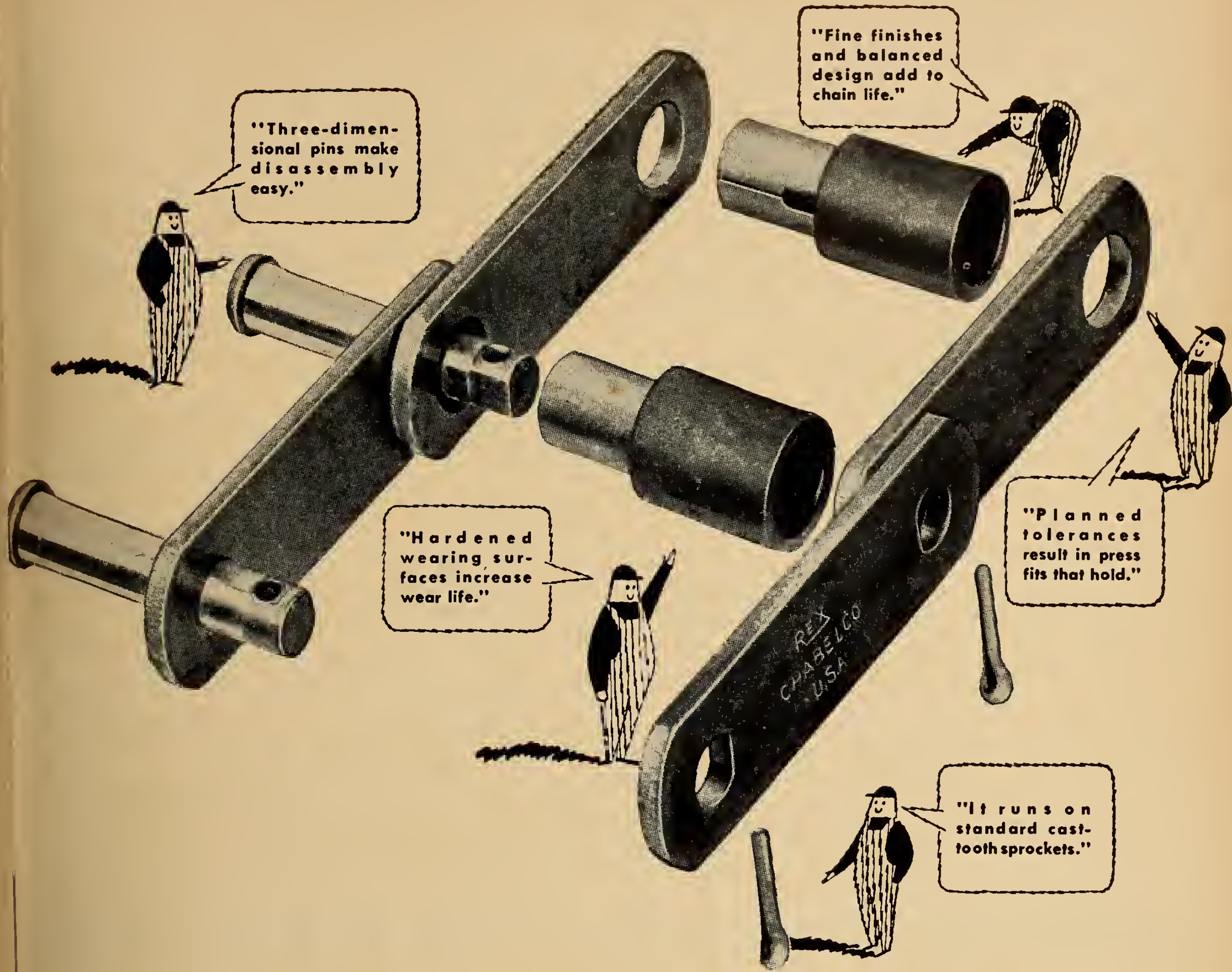
Six committee chairmen were elected. They are W. G. Heslop, program chairman; Professor J. F. Muir, chairman of student guidance; W. J. Johnson, membership chairman; J. H. Swerdfeger, technical sections chairman; C. H. White, who will take over Professional Development; and J. J. Kaller, publicity chairman.

Largest Turbine Plant

The largest gas turbine plant in the world is now being constructed at Bare Point near Chemainus, Vancouver Island, and is about to get its first turbine unit, according to John Harvey, M.E.I.C., of Sandwell and Company Mr. Harvey is engineering consultant to the B.C. Power Commission for their thermo power plant which is to take care of peak electrical loads of a total capacity of 76000 kw.

Addressing a recent meeting of the Vancouver Branch, Mr. Harvey stated that the Georgia Generating Station, designed to burn low-grade Bunker "C" oil can be readily adapted to using natural gas when it will be available on Vancouver Island.

The plant will consist of four general electric gas turbines which are economical to install and require the minimum of accessory equipment. The low-grade oil delivered by ocean-going tankers to the plant's own docks will be treated at the plant to remove impurities that



Six reasons for Rex Chabelco

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cause corrosion of the turbines nozzles and blades.

Precast Concrete Panels. Mr. Harvey further stated that the walls of the power house building designed architecturally by Thompson, Berwick and Pratt, Vancouver, architects and Phillips, Barrat and Partners, Vancouver structural consultants, will have precast walls believed to be the longest precast concrete panels in British Columbia to date.

Two Vancouver firms were selected for carrying out the construction. Northern Construction Company are the structural contractors while the Industrial Piping and Controls Limited are the mechanical contractors. Sandwell and Company are in charge of the development and supervision of the entire project.

During a lively question period, Mr. Abel was assisted by R. L. Jackson, manager, advance engineering, gas turbines and H. Karlson, manager of utilities and transportation, gas turbine sales, both of the General Electric Company, Schenectady, New York.

Members will be interested to know that reprints of the paper are available from the Canadian General Electric Company.

Chief Geologist Speaks

On Wednesday, March 27, a paper on "The Application of Geology to Soil Problems in the Lower Mainland" was presented to the Branch by Dr. J. E. Armstrong, chief geologist of the B.C. Office, Geological survey of Canada. Dr. Armstrong is a graduate of the University of British Columbia and Toronto and is presently regional vice-president of the C.I.M.M. and a Fellow of the Royal Society of Canada and the Geological Society of America. He was assisted during the discussion following his talk by Paul Cook and Professor R. A. Spence.

"Surficial Geology of Vancouver Area, B.C." Dr. Armstrong based his talk on his recently published paper by this title. The physical features of the lower mainland area were discussed together with the general geology, stratigraphy and historical geology. Emphasis was placed on the engineering geology pertaining to foundation materials, sewage disposal, flood control, slides and construction materials. The agricultural application in the area and ground water geology of the area were also commented on.

News of Other Societies

C.E.A. Meets at Murray Bay

The Canadian Electrical Association held its 67th Annual Convention at the Manoir Richelieu, Murray Bay, Que., on June 19/21, 1957. Six-hundred and fifty delegates attended. J. C. Dale, president and general manager of the Canadian Utilities Limited, Edmonton, was elected president for 1957/58. N. T. Smith of Halifax, N. S. Crerar of Arvida, and J. C. Steele of Vancouver were named as vice-presidents.

President's Address

C. E. A. president, Arthur C. Abbott, in his presidential address, recorded that growth in Canada's net generating capability during the period 1952-56 had amounted to 36.2 per cent while the indicated growth during the forecast period 1956 to 1960 would represent a further 47.6 per cent. Total growths for the period 1952 to 1960 would thus be 101 per cent for the country as a whole.

Peak power load or demand at 13,-917,000 kw. last year was forecast to rise to 19,040,000 kw. by 1960, or 91.5 per cent higher than for 1952. Firm energy requirements at 82.7 billion kilowatt hours last year would rise to 14.4 billion kilowatt hours in 1960, an increase of 37.6 per cent over the 1956 figure.

To make the best possible use of our remaining hydro-sites in years to come, very appreciably higher voltages than those at present in use would have to be employed, he observed. Provision of strong interconnections between the major power systems of the country could be taken advantage of where such interconnections could be economically justified.

From information at present available, it appeared nuclear power would continue considerably more expensive than conventionally generated power for some time to come. Techniques were changing rapidly, however, he pointed out, as evidenced by recent suspension of construction on Canada's 20,000 kw. demonstration reactor to permit a change in design.

Steps taken during recent years to combat the inflationary trends confronting the industry, he recorded, had included the following:

1. A complete review and redesign of certain items of electrical equipment.
2. Higher ratings on both hydro-electric and steam turbine units.
3. Construction of new hydro stations of the "outdoor" type.
4. Supervisory operations of hydro-electric stations.
5. Greater use of fully, semi-automatic and even completely unattended sub-stations.
6. Extensive use of large three-phase transformers.
7. Use of higher distribution voltages.
8. Rapidly developing use of live line tools.
9. Continuing studies towards the further standardization of materials and methods to obtain a higher degree of interchangeability.

Further application of these developments and others must continue, said Mr. Abbott, as power systems continue to expand, if we are to combat successfully the danger of higher construction and operating costs.

Atlantic Province Economic Council

President R. J. Rankin of the Atlantic Provinces' Economic Council, told delegates that the awakening realization of what capital and electric power could accomplish was responsible in large measure for the new spirit so apparent in the Atlantic Provinces today. This realization had brought the four Atlantic premiers together in a common front to analyse, in a continuing yearly study, the region's economic problems.

Studies made by the Council through its associations with the electrical industry had definitely established the fact that adequate power for normal requirements is presently available within the Atlantic region, he said. This power could be had at a price comparable with regions not blessed with an abundance of hydro-electric resources.

The main objective of the council, he explained, was to appraise the Atlantic region's expanding economy, and to consider how best to marshal material and human resources for greater regional development, to stimulate co-ordinated action by business and governments. Like its counterpart, the New England Council, the A.P.E.C. organization had no authority but that of public opinion, no power but that of men and ideas.

Industrial Developments in Alberta

Reviewing the tremendous expansion in the development of oil and natural gas in Alberta over the past decade, J. R. Donald, O.B.E., president J. T. Donald, and Company, (1956) Limited, pointed out that the most significant industrial growth had occurred in the production of goods for sale in external markets.

To continue its rapid progress, Alberta's industry must continue to increase its sales in prairie markets, in the rest of Canada and in foreign markets, he warned. There were the twin problems of high freight rates and long hauls. Only low production costs would enable goods from Alberta to offset them. Other factors such as taxation and wages were of equal importance. Chemicals could not be economically produced anywhere in Canada to supply the Canadian market alone.

Further immediate possibilities in the field of foreign trade included primary products, oil and gas, sulphur, pulp and paper, metals and possibly more primary chemicals and plastics. Production of elemental sulphur was increasing rapidly.

Secondary manufacture for export of synthetic rubber, petrochemicals, synthetic fibres, food, paper and metal products had a less optimistic look, he stated. It was frequently confronted with tariff barriers. Trade policies of other nations, particularly the United States, did not encourage the development of secondary industry in Canada. To assure prosperity to our primary extractive industries a moderate tariff policy had been pursued which made it impossible for Canadian secondary manufacturers to capture even the Canadian market.

Changing-Economic Climate

Addressing the meeting on Canada's economic outlook, Dr. J. R. Petrie, consulting economist of Montreal, pointed out that for two decades we had been experiencing an almost uninterrupted period of economic expansion. There had been three distinct booms since the end of World War II. The present boom was largely the result of the greatest capital expansion in our history.

World demand had stimulated resources development projects. Demand for energy resources had been strong. But many did not realize that about half the investment made by business in fixed assets last year was in the manufacturing and service industries, he oberved.

In spite of 1957 promising to be the best calendar year in our history, with gross national product 4 or 5 per cent over last year's $29.9 billion, he stated there were symptoms that we are in the later stages of the boom and in the early stages of a mild depression. Looking back a year from now we would probably see the peak of the boom had been reached last February.

Housing starts in 1957 could well be down 25 per cent, pointing to the possibility of a $60 million decline to follow in the sales of furnishing and appliances. There were surpluses of newsprint and pulp. U.S. advertising linage was down from last year. The outlook for wheat markets was unhealthy, and farm income could be adversely affected.

Base metal prices were continuing to fall. Corporation profits were probably 10 to 15 per cent lower in the first quarter than in the last quarter of 1956. Unless productivity could keep pace with rising wages we could be priced out of export markets to become marginal suppliers of many export commodities.

Investment

Though estimated investment was running seven and one-half per-cent over last year, much of this year's program seemed to be a spillover of large projects started in 1955-56. Nevertheless, despite weakness in manufacturing, commercial and financial institution building, the volume of capital outlay next year should be maintained at this year's level.

"I am not forecasting depression," concluded Dr. Petrie, "but rather the kind of rolling adjustment we experienced in 1953/54. While I observe the outlook for the next year with sobering reflections, I am still unreserved in my longer-term optimism over Canada's economic destiny."

I. I. W. Meeting in Germany

The 1957 annual assembly of the International Institute of Welding (I.I.W.) was held in Essen from June 30 to July 6, organized by the German Welding Society (DVS), and was attended by nearly 800 delegates and their wives from 21 countries. The first three days coincided with the DVS Exhibition on Welding and Cutting.

The program of the Assembly included two meetings of the Governing Council of the Institute, four meetings of each of its fifteen technical Commissions and a public session for the presentation of papers.

Dr. U. Guerrera of Italy was elected in 1956 to sueceed Dr. H. Biers (U.S.A.) as president of the I.I.W. Two vice-presidents were elected and a treasurer and a secretary-general were re-elected. They are, respectively: Prof. R. Rapatz, Austria, Prof. M. Radojkovic, Yugoslavia, W. Edstrom, Sweden, and G. Parsloe, United Kingdom.

Commissions of I.I.W.

Useful work was accomplished by the Commissions of the Institute at Essen meetings. Many of their decisions, later ratified by the Governing Council, concerned the release for publication in the technical press of documents prepared either by the Commissions or by individual members of them. These documents, numbering 22, concern as many aspects of welding practices and research and training of personnel. Information about these and other approved publications can be obtained through the member societies of I.I.W.

Twenty six papers by authors from 10 countries were presented at the public session. Several aspects of the main theme of the session. The Metallurgy of Welding, were treated by the authors.

The 1958 annual assembly will be held in Vienna, Austria, from June 29 to July 5. For the public session the theme will be Welding in the Chemical Industry. This subject will be discussed in papers in five categories: 1. the influence of the method of welding, of preheating and of finishing operations on the properties of welded assemblies; 2. welding of clad metals; lining; 3. problems in the welding of equipment for the chemical industry and for nuclear plants; 4. design and calculation of welded products working under high pressure and at high temperatures; 5. typical examples of welded constructions.

Information about the publications and activities of I.I.W. and about the Canadian membership, can be obtained from W. R. Stickney, secretary, Canadian Council of the International Institute of Welding, 7 Pleasant Blvd., Toronto, Ont. Further notes from the Canadian delegation, of particular interest to Canadian industry, will appear in the September issue.

Canadian Conferences

Of important interest to all Canadians associated with the production, use and conservation of coal is the twentieth annual Joint Solid Fuels Conference, sponsored by the A.I.M.E. and the American Society of Mechanical Engineers in co-operation with the Canadian Institute of Mining and Metallurgy, coal division, in October. The choice of the Chateau Frontenac, in historic Quebec City, will mark the first time that Canada has played host. Invitation to hold the conference in Canada was extended by the coal division of the Canadian Institute of Mining and Metallurgy, following many previous sessions held in the United States.

The program features four technical sessions. The first, on October 10, will be devoted to Canadian papers given under the auspices of the Canadian Institute of Mining and Metallurgy, coal division.

It features papers by C. L. O'Brian, assistant to the chairman, Dominion Coal Board, Ottawa; G. M. Hutt, assistant manager of the Department of Industrial Development, of the Canadian Pacific Railways, Montreal, Que.; E. Swartzman, senior technologist, of the division of fuels, Department of Mines and Technical Surveys, Ottawa; G. P. Cooper, vice-president of the Empire-Hanna Company, Toronto, Ont., and and W. J. Moroz, combustion engineer; and C. E. Baltzer, senior engineer, fuel and power, division of fuels, of the Department of Mines and Technical Surveys, Ottawa.

The three remaining technical sessions feature papers to be given under the sponsorship of A.I.M.E. and A.S.M.E.

Working on the various conference committees are Professor T. S. Spicer of the A.I.M.E., general chairman of the Conference Committee; Dr. H. B. Charmbury of the A.S.M.E. and Dr. Dufresne of C.I.M.M., acting as co-chairmen. Others involved in committee work are Dr. G. Letendre, E. R. Mitchell, and A. Ignatieff.

A diversified program for ladies accompanying the delegates is a feature of the conference program.

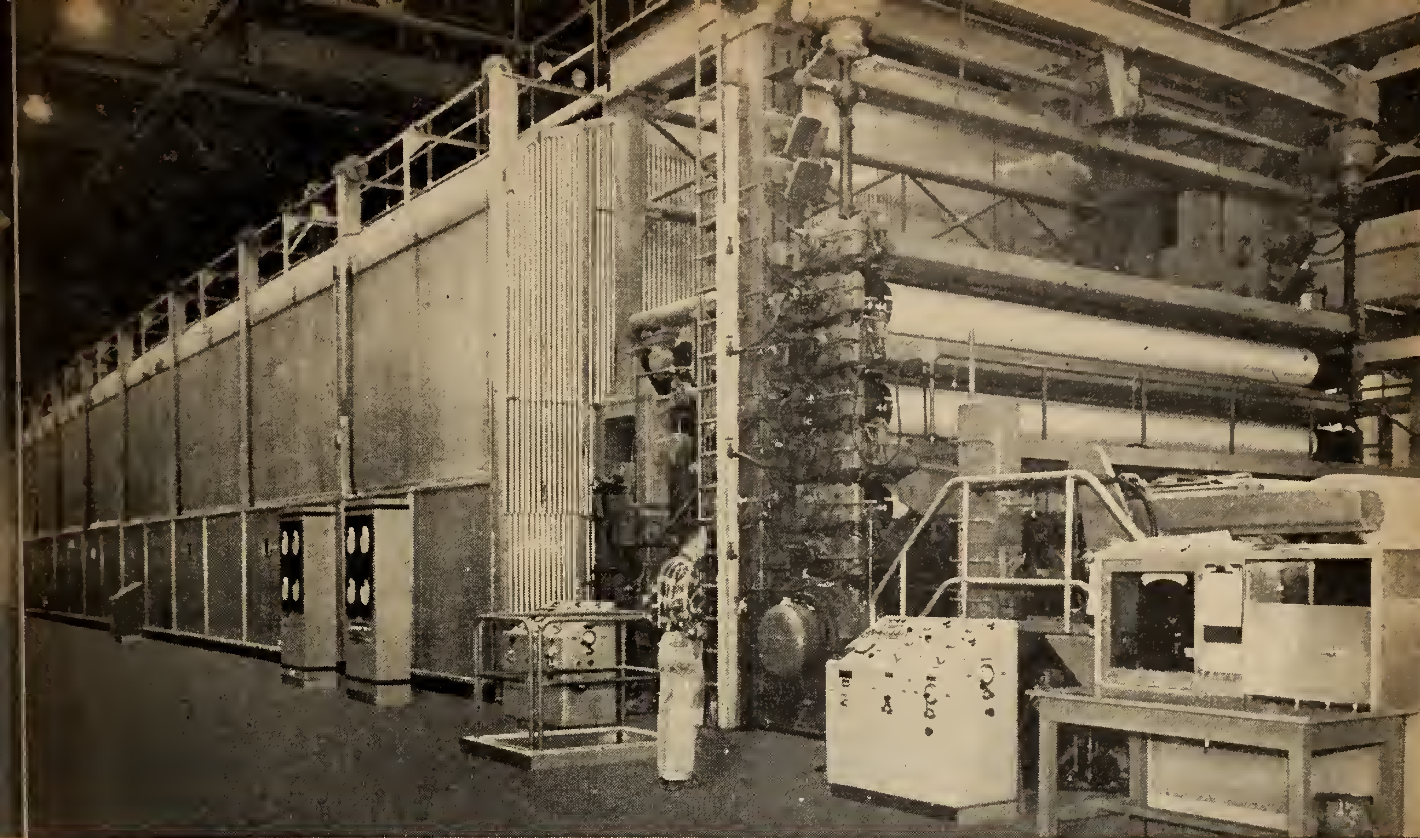
Hotel reservations should be made directly with the management of the Chatenac Frontenac.

By agreement between ASME and the Engineering Institute of Canada, E.I.C. members may attend this meeting at the same conference fee rate as A.S.M.E. members. Programs are available upon request to E.I.C. headquarters, Montreal.

Lubrication Conference

The A.S.M.E. Lubrication Conference is being held in Toronto, Ontario, October 7-9, with headquarters in the Royal York Hotel.

This extensive meeting on lubrication subjects is also open to Engineering Institute members at the same eonference. Fee rate as that of A.S.M.E. members. The Institute will have programs for distribution from Headquarters in Montreal and from the Field Office, 236 Avenue Road, Toronto.



This is the new, high speed newsprint machine at Mandos' Kenora Mill. A major part af the recent expansion, this machine is capable of turning out newsprint 21 feet wide at the rote of 2500 feet per minute (over 300 tons o day).

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ıeOntario-Minnesota Pulp and Paper Com- n Limited's (Mando) new machinery instal- in at the Kenora mill will boost production cord 100% . . . give the company a 30% rise all-round. In selecting G-E Co-ordinated pment, Mando is assured of maintaining is p production with maximum efficiency and n um downtime.

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Library Notes

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BOOK REVIEW

STATISTICAL YEARBOOK OF THE WORLD POWER CONFERENCE, NO. 8.

This eighth Yearbook issued by the World Power Conference contains statistics for the years 1952 to 1954, with some supplementary and revised statistics for earlier years, and any available for 1955.

The coverage is, as far as possible, world-wide, and the statistics give information on power resources, production, stocks, imports, exports and consumption. The power sources for which statistics are given include: solid fuels, coals and wood; liquid fuels, petroleum, benzoles and alcohols; natural and manufactured gas, water power and electricity.

The information is, as usual, presented extremely clearly in tabular form. There are two extremely useful sections listing the sources from which the statistics were obtained, and the publications which contain statistics of fuel and power (Ed. by Frederick Brown. London, Lund, Humphries, 1956. 176 p., $8.50. Obtainable in Canada from the E.I.C. Library.)

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

ABSTRACTS OF LITERATURE ON SEMICONDUCTING AND LUMINESCENT MATERIALS AND THEIR APPLICATIONS

The period covered by this third volume in the series sponsored by the Electrochemical Society is 1955. There are nearly five-hundred more abstracts than in the volume for 1954, reflecting the increased use of semiconductor and luminescent materials in transistors, rectifiers, coloured television screens, etc.

The abstracts are grouped by material; germanium, silicon, carbon, selenium, sulfides, etc., and there are subject and author indices. The material has once again been compiled by the staff of the Battelle Memorial Institute. (Ed. by E. Paskell. New York, Wiley, 1957. 322p. $10.00.)

*ACOUSTICAL ENGINEERING

About one-third larger than the author's "Elements of Acoustical Engineering" 1947, on which it is based, the present volume has been revised throughout and includes two new chapters on complete sound reproducing systems, and means for the communication of information. Dealt with in other chapters are subjects such as ultrasonics, underwater sound, speech, music, hearing, transducers, microphones, loudspeakers, and acoustical radiating and mechanical vibrating systems. References are scattered throughout the book. (By H. F. Olson. Toronto, Van Nostrand, 718p., $13.50.)

AIR CONDITIONING

Written by a professor of mechanical engineering and a consulting engineer, this basic textbook presents the fundamentals of the design of heating and cooling systems, placing particular emhasis on the cooling problems found in hot-humid and hot-d[illegible] climates.

The first part of the book deals with the thermodynamics of air conditioning, and the problems of system load determination and design, including the psychrometric chart and processes. Parts two and three cover the various types of heating and cooling systems, while the last part deals with various problems arising in connection with the air conditioning in the fields of piping design, automatic control and air contaminant control.

The authors have placed emphasis on the general problems concerned with the design of heating and air conditioning systems, rather than giving details which can better be found in trade literature and manufacturers manuals. The authors have provided bibliographies and problems at the end of each chapter. (By W. R. Woolrich and W. R. Woolrich Jr. New York, Ronald, 1957. 384p., $7.50.)

CANADIAN TRADE INDEX

This latest edition of a valuable trade index published by the Canadian Manufacturers Association contains an almost complete list of Canadian manufacturers, both alphabetically by name (and address) and classified under some 10,000 product headings, ranging from abattoir equipment to zirconium.

Other sections include a list of producers, shippers and exporters of agricultural produce, a French glossary and advertisements, together with an index to advertisers.

This book is invaluable to all those connected in any way with manufacturing and purchasing. (Toronto, Canadian Manufacturers Association, 1957, 1087p., $10.00.)

CAST METALS HANDBOOK, 4TH ED.

This fourth edition of a popular re[ference book has been three years i[n] preparation and covers the various a[spects of casting, and the metals use[d].

The first section deals with the ad[vantages of castings and the gener[al] properties of cast metals, casting desig[n] costs etc. The second section cove[rs]

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• LIBRARY NOTES

gray and white cast irons including metallurgy, methods of manufacture, the various properties of cast iron, and heat treatment of gray iron. There is a 392 item bibliography.

Sections three and four discuss malleable and nodular cast iron, and the remaining sections cover steel castings and nonferrous alloys.

The book is clearly written, much of the material being presented in tabular and graph form, and there are many illustrations and bibliographies in addition to the one already mentioned. (H. Bornstein, Chief ed. Des Plaines, American Foundrymen's Society, 1957. 316p.)

°CHEMICAL ENGINEERING PRACTICE, V. 3, SOLID SYSTEMS

The title of this comprehensive volume fails to disclose its pertinence to mining, metallurgical, and chemical engineers. It deals with (1) size reduction: crushing, grinding and pulverizing equipment and principles; (2) screening, grading and classifying: tabling, jigging, flotation, sedimentation, airflow selection, wet classification, and washing; (3) mixing of solids; (4) storage and handling of solids: sampling, measuring and gauging; (5) cleaning gaseous media: cyclones, and electro-precipitation. Numerous graphs, charts, diagrams of machinery, and references are included in this the third volume of a twelve volume set on chemical engineering practice. (By H. W. Cremer and T. Davies, eds. Toronto, Butterworth, 1957. 534p., $17.50.)

LA CHIMIE NUCLEAIRE ET SES APPLICATIONS

The content of this volume is much wider than indicated by its title, for in it the author has tried to prevent a survey of modern knowledge in nuclear chemistry, radiochemistry, and the chemistry of radiations and their applications.

The work falls into three sections, the first of which covers the properties and transformations of nucleii and isotopes. The second group of chapters covers the action of radiation on matter and its chemical and biological consequences. The final section discusses the principles of separation and preparation of radioactive bodies, and the application of radioisotopes etc. in physical chemistry, biology and industry.

This valuable work will be welcomed by all connected with the nuclear field, and by those wishing to learn about it. The author has drawn widely on information which has appeared in technical journals, and he lists his sources in the footnotes. (By M. Haissinsky. Paris, Masson, 1957. 651p., 5000fr.)

°CONTROL OF STEEL CONSTRUCTION TO AVOID BRITTLE FAILURE

Prepared by the Plasticty Committee of the Welding Research Council, this compact volume is a general reference and guide for engineers, fabricators, and designers in the structural field. Part 1 deals with the basic concepts and mechanisms of notch brittleness and with the mechanical and metallurgical factors affecting the plastic behaviour of structural materials. Part II shows how conventional fabrication procedures affect notch ductility of these materials. Part III deals with the selection of materials and fabricating procedures, the limits of conventional design methods; and the use of notch-brittle test data. A glossary completes the volume. (M. E. Shank, ed. New York, Welding Research Council, 1957. 184p., $4.50.)

DER STRASSENBAU, TEIL 1

The first of a projected two volumes on highway engineering, this volume by a well-known German engineer commences with an historical introduction and a brief discussion of the various types of road transport. Succeeding chapters cover in great detail route location, road dimensions, and road foundations, materials, etc. The book is well illustrated, and there is a bibliography, most of the items listed being in German.

The second volume will deal with such topics as equipment, maintenance, plans, construction and city streets. These two volumes should prove very useful, giving as they do the latest German practices in the field. (By Johannes Kastl. Leipzig, Teubner, 1957. 364p., 23DM.)

• LIBRARY NOTES

DESIGN OF WELDED JOINTS
HEAT TREATMENT OF WELDED CONSTRUCTIONS

These two booklets issued by the British Welding Research Association are part of a series covering various aspects of welding.

The first deals with the conditions of loading likely to be met in practice, tension, compression, shear etc., and gives practical design details, all with the object of enabling a designer to specify the correct sizes of welds, so that they will be neither inadequate and cause failure nor oversize and cause waste.

The second booklet lists the main factors to consider when deciding whether to heat treat a construction. It includes information on stress-relief data for typical steels and on equipment used. (London, British Welding Research Assoc., 1956. 7/6 and 5/-.)

DIGITAL COMPUTER PROGRAMMING

This book, one of a series written by General Electric authors on various aspects of engineering practice, provides a general introduction to the field of computer programming, and emphasises basic principles applicable to all computers, rather than to a single machine.

The author begins by discussing the elements of a computer and their relationships, together with information on coding, binary and octal number systems and decimal point location methods.

The fundamental principles of programming are given with many examples and explanations, applied to a mythical computer TYDAC, Typical Digital Automatic Computer, which is representative of current models.

This book will be valuable to those wanting to know how to prepare a programme for a computer, and for those whose work is closely related to computer applications, and who need to know what is involved in programming. The book may be read either with or without a machine on which to practice. There is a useful bibliography. (By D. D. McCracken. New York, Wiley, 1957. 253p., $7.75.)

*FUNDAMENTALS OF STATICALLY INDETERMINATE STRUCTURES

A college text which focuses attention on the basic concepts of statically indeterminate structures. All methods and topics are carefully related and coordinated through their development from these fundamental concepts, and the subject is developed as an integrated whole rather than as a consideration of numerous unrelated methods. The book is planned so that it may be used as a text in a one-semester or two-semester course. (By C. L. Shermer. New York, Ronald Press, 1957. 264p., $6.50.)

GETTING STARTED IN AMATEUR RADIO

Intended for persons living in the United States wishing to obtain their Novice Class licenses as radio amateurs, this book describes the various classes of licence and the steps to take to obtain them.

The book contains information on the Morse Code and how to learn it and on the basic electronics and radio theory required for the examinations. Typical examination questions and their answers are also included. No particular technical knowledge is required for an understanding of the book. (By Julius Berens. New York, Rider, 1957. 136p., $2.40.)

*HEATING VENTILATING AIR CONDITIONING GUIDE, VOLUME 35, 1957

Topics newly or more extensively treated in this year's volume include U-value tables for building construction; sound control; control of industrial environment; design of ceiling and floor heating panels; and forced warm air systems. The volume, an authoritative guide to current practice, is made up of seven main sections dealing with fundamentals, human reactions, heating and cooling loads, combustion and consump-

tion of fuels, systems and equipment, special systems, and instruments and codes. A manufacturers' catalog data section is included. (New York, American Society of Heating and Air-Conditioning Engineers, Inc. 520p., $12.00.)

INDUSTRIAL ORGANIZATION AND MANAGEMENT, 3RD ED.

This revised edition reflects the changes which have taken place in management's thinking and practices during and since the war. The author discusses management principles and policies in business and industry, and deals with the objectives, policies, functions and relationships which govern the work of the production division of a manufacturing firm.

The first four chapters cover the development of modern management and its organization, while succeeding chapters discuss marketing; plant location; the relation between research and new product development; the manufacturing plant, including materials handling and lighting; motion and time study; production control; quality control; personnel office management, etc. A final chapter considers long-range planning and inter-plant coordination.

An eleven page bibliography and a glossary of the terms encountered conclude this extremely useful volume. (By R. C. Davis. New York, Harper, 1957. 953p., $8.50.)

AN INTRODUCTION TO WORKSHOP PRACTICE, 2ND ED.

The main processes found in an engineering workshop are here presented in outline form. The book is intended as an introduction to workshop techniques for students, and covers such topics as industrial metals; use of hand tools; measuring tools; drills and drilling; gauges and jigs; lathe tools and lathes; planing and shaping machines; milling; grinding and belts and transmission.

The book is illustrated with many line drawings. (By P. E. Ellis. Glasgow, Blackie, 1957. 184p., 7/6.)

*JETS, WAKES, AND CAVITIES

A monograph devoted to the quantitative scientific analysis of jets, wakes and cavities. The book treats first, in chapters II-XI, the applications of Euler's differential equations to flows with free boundaries, i.e., to liquid flows bounded by a liquid-gas interface. In chapters XII-XIV attention is given to cases of laminar viscous, periodic, and turbulent jets and wakes. Chapter XV summarizes limitations on deductions made in the first portion of the book. There is an extensive bibliography. (By G. Birkhoff and E. H. Zarantonella. New York, Academic Press, 1957. 353p., $10.00.)

*MAINTENANCE ENGINEERING HANDBOOK

This comprehensive handbook, containing contributions by more than eighty men, devotes about a third of the book to the management aspects of maintenance, such as organization and administration of maintenance forces, personnel, planning and scheduling, project control, and costs and budgets for maintenance operations. The remaining two thirds of the book cover the selection, installation, and upkeep of buildings; electrical, mechanical, service, and transportation equipment; maintenance stores and their control; lubricants and lubrication; instruments; sanitation; welding; and corrosion. Units of production equipment dealt with include bearings, clutches, chains, drives, gears, valves, etc. (Ed. by L. C. Morrow. Toronto, McGraw-Hill, 1957. Various pagings, $20.00.)

MANUFACTURING PROCESSES, 4TH ED.

Completely revised, this fourth edition provides a comprehensive survey of manufacturing materials and processes, placing greater emphasis on principles and materials.

New topics covered include electroforming and metal coating processes, electro-spark machining, chem-milling, and automation. The chapters on foundry equipment and procedures, press work, plastic molding, and drilling and boring machines have been rewritten.

The photographs have been revised to show modern equipment, and the working of many of the machines is shown by line drawings.

Bibliographies for further reading have been provided at the end of each chapter, and the book will be useful not only to students wishing to obtain a basic knowledge of the materials and processes found in industry, but also to practicing engineers and others wanting to review a special phase of metal processing. (By M. L. Begeman. New York, Wiley, 1957. 612p., $8.00.)

MECHANICAL VIBRATIONS

Designed for a first course in the fundamental theory of mechanical vibrations, the purpose of this book is to enable the student to master the mathematical techniques which will later enable him to make the most use of more advanced literature.

The book assumes a grounding in integral calculus, and covers linear differential equations; partial derivatives in enough detail to enable the Lagrange equations to be developed; the solution of partial differential equations by the method of separation of variables; and, finally, introduces the electrical analogy, the mobility method and an introductory discussion of the analogue computer. (By Bernard Morrill. New York, Ronald, 1957. 262p., $6.50.)

°MODERN PULP AND PAPER MAKING, 3RD ED.

A revision of the previous editions by George S. Witham, this third edition has been rewritten by authorities in the field. Full coverage is given to such subjects as: papermaking materials and processes, varieties of paper and paperboard, the sulfite process, the alkaline processes, pulp bleaching, the machine and finishing rooms, paper defects, testing of paper and paper materials, process instrumentation for the pulp and paper industry. References are included. (Revised and edited by John P. Calkin. New York, Reinhold, 1957. 549p., $10.00.)

NEIGHBOURHOOD PLANNING

The author defines a neighbourhood as "an urban unit with a functional arrangement of its environmental elements, those elements being the circulation system, the built-up and the open spaces, the building sites, and the recreational, educational and social welfare facilities." The neighbourhood is further defined as being the smallest unit of population which can support an elementary school, that is about 4000 people. The neighbourhood is composed of a series of housing groups of from 50 to 300 people.

Professor Kostka considers all the aspects of planning a unit of this type, including architectural and engineering problems, zoning, the density of population desirable, the best methods of handling local and through traffic, and the utilization of real estate.

Much of the text is organized round 45 scale plans, illustrating house layout, street planning and subdivision design. Examples of planned neighbourhoods are given: Edmonton and Kitimat in Canada, Harlow, Crawley and Hatfield in England.

All those concerned in any way with city planning will welcome this latest book by Professor Kostka. It is a companion volume to his earlier *Planning Residential Subdivisions*, and should enjoy the same popularity. (By V. J. Kostka. Obtainable from the author, University of Manitoba Community Planning, Winnipeg 9. 1957. 142p., $4.00.)

NOMOGRAMS FOR THE ANALYSIS OF FRAMES

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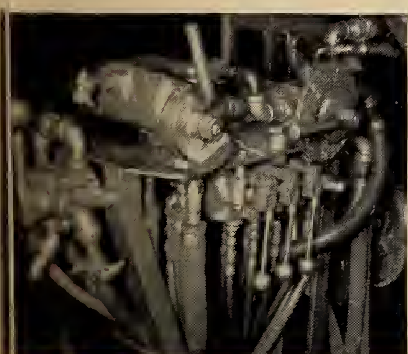

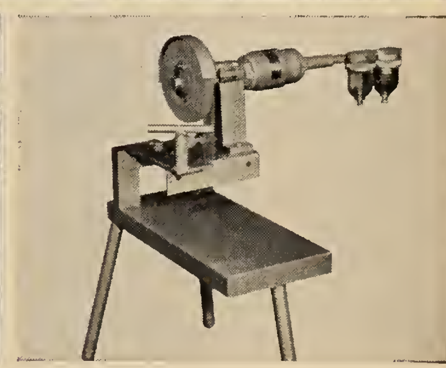

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rectangular building frames, and they are equally useful for reinforced concrete and steel construction. The cases dealt with are frames with both columns fixed at the base, both columns hinged at the base, and both columns fixed at the base and hinged at the top. The nomograms relate to the design of such frames with eight different types of loading, namely concentrated, uniformly-distributed, and triangular loads on the beam; concentrated, uniformly-distributed and triangular loads on either or both of the columns; external loads acting on the beam or on a column. Simple, symmetrical, and antimetrical loads are dealt with.

Complete formulae are given for all the foregoing conditions. The principal advantage of the nomograms is the speed with which indeterminate quantities are obtained by reading from the nomograms certain non-dimensional coefficients that are functions of the properties of the frame and the nature and position of the load.

The nomograms are in a pocket at the back of the book, so that they can be laid on the drawing board when in use, and their use is demonstrated by numerical examples." (By J. Rygol. London, Concrete Publications, 1957. 53p., $4.00.)

NOUVELLE CONCEPTION DE LA RESISTANCE DES MATERIAUX

In this second edition of his work on the strength of materials, the author has revised the chapters dealing with double functional anisotropy, concrete and clay under torsion-compression, concrete beams under shear and arches loaded at the crown as the existence of a second functional anisotropy has been confirmed since the publication of the first edition.

The material contained in the book appeared originally in the French publication, Genie Civil. (By A. Couard. Paris, Genie Civil, 1957. 111p., 1200fr.)

*NUCLEAR POWER ENGINEERING

An elementary presentation of the basic facts of the physics, design, materials, economics, and operation of nuclear power plants. The material is a revised and augmented reprint of a series of articles published in POWER starting in July 1954. (By H. C. Schwenk, R. H. Shannon and B. C. Skrotzki. Toronto, McGraw-Hill, 1957. 319 p., $7.80.)

PHYSICS OF NON-DESTRUCTIVE TESTING

The sixth supplement issued to the British Journal of Applied Physics, this volume contains papers presented at meetings of the Non-Destructive Testing Group of the Institute of Physics. The purpose in publishing the papers is to show engineers and metallurgists the importance in non-destructive testing of the new methods resulting from the application of physics.

Some of the topics covered include: the potentialities of X-ray diffraction studies; the principles of penetrant methods; principles and applications of nuclear magnetic resonance; effects of penetrating radiations on materials; and the measurement of elastic constants by the ultrasonic pulse method. (London, Institute of Physics, 1957. 72 p., 25/-.)

*PRACTICAL ACCOUNTING AND COST KEEPING FOR CONTRACTORS, 5TH ED.

The essentials of accurate cost keeping are described for contractors involved in both large and small operations. The book includes complete labor and material cost schedules, information on how costs should be reported from the job, how to gather and compile data from checking the workmen's time on distributing the labor hours, and on working costs into suitable units. Illustrations and descriptions of forms required, i.e., Social Security records, expense sheets, etc. are included. (By F. R. Walker, Chicago, Frank R. Walker, 1957. 255p., $5.00.)

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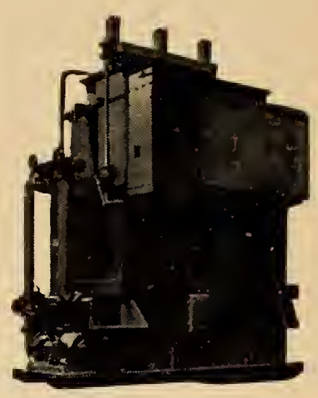

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is now universally recognized, and a systematic inspection programme plays a big part in lowering production costs.

This book, the most recent on the subject, is based on the syllabus of the City and Guilds of London Institute, and covers organization and scope of the inspection department, methods, machines and sampling, and the use of quality control charts. It is concerned not only with the finished product, but also with materials, both metallic and non-metallic, and protective coatings. There are illustrations of many machines, and line drawings showing their operation. Both authors have had experience in inspection work and in teaching. (By G. K. King and C. T. Butler. London, Cleaver-Hume, 1957. 264p., 25/-.)

°PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE, 11TH ED.

Provides useful information on all phases of arc welding for the machine designer, the structural engineer, the fabricator, the welder and all those interested in metal joining. The 8 sections cover: history, nomenclature and processes, weldability, mild steel procedures, manufacturing cost data, machine design, structural design, applications and reference data. The structural section has been completely rewritten and includes the latest data on welded design. The weldability section includes information on welding such new materials as zirconium and titanium (Toronto, Lincoln Electric Co., 1957. Various paging, $3.00.)

RESOLUTION NUMERIQUE DES EQUATIONS ALGEBRIQUES

This text on the numerical solution of algebraic equations with real or complex coefficients discusses methods of calculation leading to valid solutions which are not always possible by more usual methods.

The various methods are presented in a logical order, and their practical value is discussed, both from the theoretical point of view, and by means of examples.

This is the third of a series covering calculation methods, and is intended for engineers, architects, builders etc. (By Jean Peltier. Paris, Gauthier-Villars, 1957. 244p., 2500fr.)

SCIENTIFIC FRENCH

Intended to enable English speaking scientists and engineers to obtain a reading knowledge of scientific French very quickly, this textbook emphasises the analytical approach throughout and grammatical terminology is kept to a minimum. Particular attention is paid to the structural differences between the two languages, and after a careful study of the book, which can also be used as a reference grammer book, the reader should be able to translate any ordinary technical material with the aid of a dictionary. (By W. N. Locke. New York, Wiley, 1957. 112p., $2.25.)

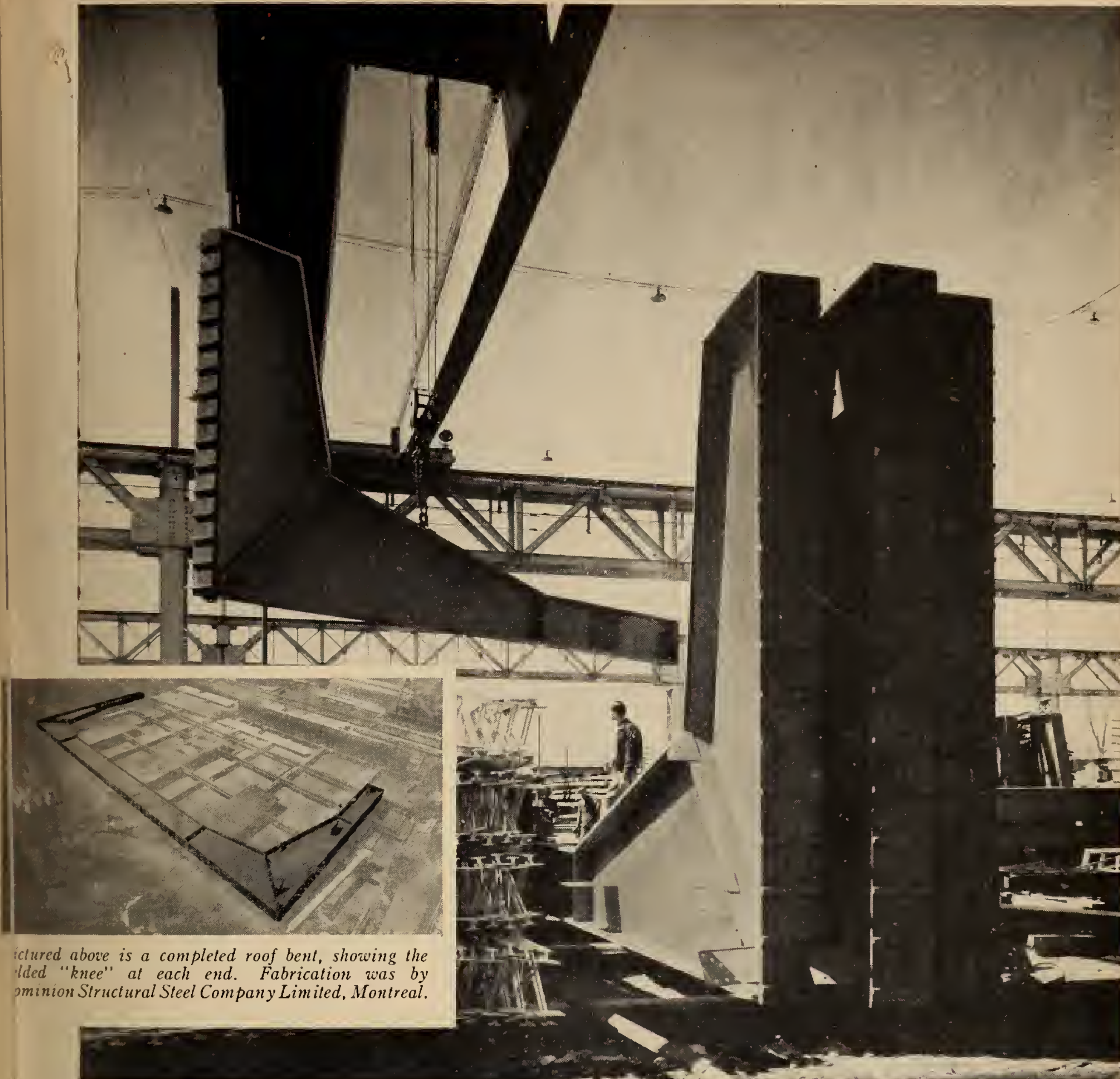
SCIENTIFIC GERMAN

Written with the same scope and purpose as Scientific French mentioned above, this book will prove equally useful and effective. (By G. E. Condoyannis. New York, Wiley, 1957. 164p., $2.50.)

THE THEORY OF SUSPENSION BRIDGES

The author is to be congratulated on providing a textbook on a topic about which suprisingly little has been written. The book will prove useful not only to students, but also to practicing engineers.

The historical introduction is followed by a discussion of the simple cable under applied loads. The various theories found in connection with the design of suspension bridges are considered: the Rankine, elastic, deflection and linearised deflection theories, anl the Fourier series treat-



ictured above is a completed roof bent, showing the ·lded "knee" at each end. Fabrication was by ominion Structural Steel Company Limited, Montreal.

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ment of the deflection theory. Methods of analysis for preliminary design are given, and considerable attention is paid to the oscillations of suspension bridges, including of course the failure of the Tacoma Narrows Bridge.

The treatment of the book throughout is mathematical. There are numerous bibliographical references (By Sir Alfred Pugslev. Toronto, Macmillan, 1957. 136p., $7.15.)

TRANSISTOR CIRCUIT ENGINEERING

The object of this book is to show how basic transistor theory can be used in typical circuits.

Commencing with the basic theory and the application of network theory to it, the book goes on to cover basic circuits; audio amplifier designing; d-c, tuned and video amplifiers; oscillators; modulation, mixing and detection; and transient response and pulse circuits.

The book will enable the reader to build audio amplifiers, etc., using available transistors, and it shows how the circuits are combined into radio and television sets and high fidelity systems. Information is also given on the development of new devices and their application. There is an extensive bibliography for those who wish to pursue the subject further. (Ed. by R. F. Shea. New York, Wiley, 1957. 468p., $12.00.)

VECTOR SPACES AND MATRICES

The growing interest in vector spaces and matrices is reflected in the replacement of college courses on theory of equations by ones on matrix theory. Matrices and vectors, apart from their use in mathematics, are also used in circuit analysis, quantum mechanics, statistics and operations research.

This volume, intended as a college text, introduces vector spaces and linear transformations and matrices, and covers such topics as: systems of linear equations, determinants, functions of vectors, structure of polynomial rings, similarity of matrices, linear inequalities, etc.

These books are written at two levels, one concrete and the other axiomatic, the concrete one being through matrices and the other through linear transformations. This method has the advantage of introducing the reader to mathematical reasoning based on a set of axioms, while still retaining concrete examples. The final chapter provides an introduction to the theory of games and linear programming. (By R. M. Thrall and L. Tornheim. New York, Wiley, 1957. 318p., $6.75.)

WATER

This 1955 Yearbook of the U.S. Department of Agriculture is devoted to what is now a major concern, not only in the United States, but in Canada and the rest of the world. Water. The aim of the book is "to explain the nature, behaviour, and conservation of water in agriculture . . . Hydroelectric power, navigation, industrial use, pollution, and other aspects are touched on, but the book is concerned almost entirely with water in agriculture."

Some of the topics covered in this readable book are: the need for water; sources of supply; the action of water on soil; conservation; irrigation; drainage and pure water supply for farms and cities.

There are suggestions for further reading in each chapter, and the final chapters are concerned with future needs and the research and regulation needed to increase and conserve the available water supply. (Dept. of Agriculture. Washington, G.P.O. 751p., $2.00.)

WHO'S WHO, 1957

An annual publication since 1849, this latest edition of Who's Who needs no introduction. Its more than 3300 pages are a source of detailed information on anyone of note living in the British Isles or elsewhere in the world. The information given is checked by the biographee, and inclusion is, as always, by invitation and not by payment.

Who's Who is essential in any library, and is also fascinating reading. (Toronto, Macmillan, 1957. 3363p., $18.00.)

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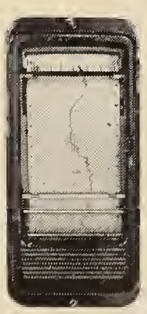

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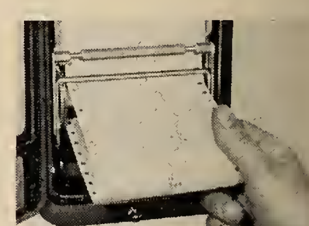

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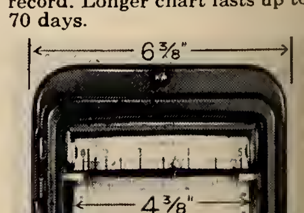

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Exploration for Oil and Gas

J. G. Spratt

Executive Vice-President,
Triad Oil Company Limited, Calgary, Alberta.

Read at the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June, 1957.

OIL EXPLORATION is one of the major gambles of modern in-lustry. It is in effect a series of ;iant, world-wide research projects vhich require vast sums of money, vith results for the most part being iegative and disappointing. Also as in esearch, however, occasional impor-ant discoveries are made which jus-fy the over-all effort.

Although oil has been known and sed by man for several thousand ears, exploration by well drilling as e know it today began about 100 ears ago. The early peoples in cer-in sections of Asia, Africa, Europe d the Americas used petroleum om surface seepages for paving ads, water-proofing boats and cis-rns, for lighting and fuel, for medi-nal purposes, and embalming. The abylonians and early Chinese are id to have produced oil from hand-g wells as far back as 5,000 years o.

For the purposes of this discussion, l will mean all members of the troleum family, which consists of a mplex series of hydrocarbons rang-g from solids like asphalt to liquid ude oils and natural gas.

The first oil found by drilling in rth America occurred in Pennsyl-nia and in Ontario in the late 50's, production being found at allow depths of less than 100 feet. With the coming of the machine e oil consumption mounted rapidly, d now thousands of wells are being illed annually in various parts of e world, with depths of over 20,-0 feet occasionally being reached. pths of 10,000 to 15,000 feet are t uncommon, with 5,000 to 10,000 et being quite common. World ergy requirements are now about ubling each succeeding decade, and it appears that oil require-ments will continue to increase in spite of the rapid advances being made in the development of other sources, such as atomic energy.

Early drilling was confined mostly to shallow wells in the vicinity of sur-face seepages, or where oil had been found in wells drilled for water or brine. As time went on, holes were gradually carried down to greater depth, and drilling became more widespread. As development con-tinued it was observed that several characteristics were common to dif-ferent oil fields. It was found that oil did not come from underground lakes and rivers, but from the pore spaces in rocks such as sandstones and lime-stones. It was also noticed that oil and salt water were commonly found together, or in close proximity, and that oil in commercial quantities often occurred in places where rocks had been buckled or arched upward into dome-like formations, and that salt water occurred immediately below, or down the slope from the oil.

Petroleum products have been known for thousands of years, mostly from natural seepages. The search for oil and gas deposits to meet the demands of modern in-dustry is the subject of this paper.

Such observations were the begin-nings of the scientific approach to oil finding. First came the application of geology, later to be followed by a more specialized branch known as petroleum geology which in turn was later complemented by the applica-tion of geophysics, geochemistry, and petroleum engineering. The result is that nowadays almost every branch of science and engineering, in some form, plays a part in the search for petroleum.

To summarize the highlights of ex-ploration in the short time available today, comments will be confined to brief remarks on the origin of oil, methods of prospecting, and the acquisition of mineral rights.

Origin of Oil

Based on present knowledge, the world is believed to be something over two billion years old, and the rocks in which oil is found date back over approximately the past 500 mil-lion years.

The earth is considered to have been formerly a molten mass of mat-ter like the sun, which eventually cooled and solidified on the outside to form what is known as the earth's crust. The crust was not a smooth surface, but was irregular and wrin-kled. The high places became the continents, and the low places the oceans, which gradually filled with water condensed from the cooling of the steamy atmosphere which sur-rounded the earth as its surface changed from a molten to a solid condition.

As time went on, primitive life be-gan to appear in the oceans, first in simple form and often of microscopic size, later developing through the slow process of evolution into the countless forms of plant and animal life which inhabit the earth today.

Oil, like coal, is classified as an organic mineral. Unlike coal, how-ever, which is a solid, oil is fluid and mobile, and generally has mi-grated some distance from its point of origin. It is believed to have been formed from the decay and slow distillation of plant and animal remains buried in the muddy bottoms of ancient seas. As time went on, new sediments were washed into the oceans by erosion of the continents, and the process, which continued through the ages, resulted in the building up of thousands of feet of sedimentary rocks, composed of limestones, shales or clays, and sandstones. During the process the ocean bottoms would periodically rise up above sea level to form continents or parts of continents, later sinking again into the sea.

The section of the Rocky Mountains which surrounds us here at Banff is formed of sedimentary rocks which were under the oceans not once but several times, and are now uplifted to heights of 5,000 to 10,000 feet above sea level. These same formations lie buried at depths of several thousand feet to the east of us in the foothills and plains of Western Canada, where some of them are occasionally productive of oil and gas.

With the passage of time and the combination of heat and pressure to which the sediments have been subjected, due to the weight of overlying formations; and with the forces which are constantly changing the shape of the earth's surface, oil was gradually formed from the organic content of the sediments in which early life was buried. Along with salt water, which was also trapped in these same sediments, the oil and water were squeezed out of the tight and relatively impervious rocks in which they were originally buried, such as clays, shales and clay-like limestones, and followed the lines of least resistance into the nearest overlying or underlying rocks, like porous limestones or sandstones. Such rocks are known as "reservoir rocks", whereas the clays and dense limestones in which the oil originally is thought to have formed are known as "source rocks". Oil being lighter than water would float on top of the water in the reservoir rock, and occasionally be trapped in commercial quantities when its migration was stopped by some barrier such as the top of a wrinkle, known as an anticline or dome, or when porosity ended abruptly due to a break in the rocks, known as a fault, or due to its petering out in a wedge-shaped up-dip direction. Where oil is found in wrinkles or against faults, such accumulations are known as structural traps, examples of which are: Turner Valley, Pincher Creek, and Fort St. John in Western Canada. When oil is trapped in an upward pinching out or wedging of porosity, it is known as a stratigraphic trap; examples of which are: Pembina, Harmattan-Elkton, Medicine Hat, and several other fields in Western Canada. Another type of stratigraphic trap is when oil is found in ancient limestone reefs, examples of which are: Leduc, Redwater, and Sturgeon Lake.

Exploration Methods

As for scientific methods employed in oil finding, the first, as already noted, is the application of petroleum geology. The job of the geologist is to make a study of the country and find out which areas are underlain by sedimentary rocks, which are favourable for oil accumulation. Areas underlain by igneous or volcanic rocks, such as granites, lavas, etc., are unfavourable for oil occurrences.

In Canada the largest area for favourable oil exploration is the sedimentary basin of the Western Canada plains and foothills. It covers an area of about 750,000 square miles, being bounded on the west by the Rocky Mountains, on the east by the Pre-Cambrian Shield, on the south by the United States border, (although the basin extends southward into the United States), and on the north by the Arctic Ocean. Taking the area by provinces or territories, it includes: (1) the MacKenzie River Basin area of the Northwest Territories, running southward from the mouth of the MacKenzie to the Alberta-B.C. boundaries; (2) part of northeastern B.C.: (3) most of Alberta; (4) the southern half of Saskatchewan; and (5) the south-western part of Manitoba.

The geologist, after making broad regional reconnaissance surveys, then proceeds to map the country in more detail, piecing together the bits and pieces of information yielded by surface rock outcrops. From such information he attempts to determine the stratigraphic and structural nature of the underground formations.

Surface outcrops usually do not provide sufficient evidence for location of exploratory wells, and additional information must therefore be sought. Surface geology is therefore often supplemented by obtaining sub-surface information from a series of shallow, strategically located test holes. Such holes are normally drilled from 50 to 1,000 feet in depth. Records of all previously drilled deep wells are also carefully studied for geological information and showings of gas, oil or water.

In studying well records, two types of scientific instruments which measure and record the electrical or radioactive nature of sub-surface strata are used. They are known respectively as electric, and neutron or gamma ray logs. In both cases instruments are lowered into the hole on a cable to measure and record the above-mentioned characteristics. The information thus obtained assists geological correlation and also helps detect possible oil bearing rocks. Another type of instrument is sometimes used in deep well drilling, which helps indicate the presence of oil or gas during drilling operations. The drilling mud, which is continually being circulated from the top of the hole down through the inside of the dril pipe to the bottom of the hole an back up to the surface in the annulu between the outside of the drill pip and the well, is tested for hydro carbon content.

During the past twenty-five years geophysics has played a very prominent part in providing helpful guidance in oil exploration. The geophysi cist is a highly scientific individua well trained in mathematics and phy sics, combined with some geologica training. He works in close collabora tion with the geologist, and employ a variety of instruments to measur magnetic, electric, gravitational, an seismic characteristics of unde ground rocks.

The most popular and successfu and also the most expensive, ge physical method employed is o known as the seismograph. Broad speaking, the principle of this meth consists of exploding dynamite in t bottom of shallow holes, which a located and drilled in specific pa terns. The explosion sends shock sound waves downward through t various rock strata, which are in tu reflected back to the surface a picked up and recorded by seism instruments in a similar manner which earthquake waves are recor ed. Results may be obtainable depths of 10,000 to 15,000 feet more. By having some idea of t velocity of sound in different form tions, and learning to detect refl tion characteristics of certain stra the seismologist is often able to d termine the nature of undergrou structure and, if the other geologi requisites are present, to locate vourable oil prospects.

The magnetic and gravimet

methods are faster and less expensive than the seismic method. They are also less accurate, being more difficult to relate to the geology, and as a rule are used more for preliminary reconnaissance, to be followed by seismic work for more detailed control.

After employing one or more of the geological and/or geophysical tools necessary for the location of deep test exploratory holes, known as "wildcats" in the oil industry, comes the actual selection of a drill site. A "wildcat", incidentally, is a respectable term in the oil business, and does not necessarily mean a fly-by-night promotion as in mining circles.

One would think that after the employment of so much technical assistance, together with the information and experience obtained from the drilling of many thousands of wells and many hundreds of oil and gas fields during the past fifty years, it should now be easy to locate oil. The fact is, however, that it is still an extremely risky business. In this country, maybe one out of ten wildcats will find oil or gas; one out of twenty may be of commercial importance; and one in several hundred may be sufficiently profitable to make up for all the failures. One of the reasons is that, although science can help reduce the odds in finding oil by helping to locate favourable underground conditions, there is still no known method of locating oil itself before drilling. Luck still plays a most important part. In actual drilling, it is often found that in spite of all the geological and geophysical work that has been done, sub-surface conditions do not turn out as anticipated. In other cases, although favourable conditions forecast before drilling turn out as predicted, for some unforeseen reason the objective reservoir rock ends up in producing water rather than oil, or is too tight or impervious to produce anything.

Fortunately, however, science occasionally leads us to discoveries of major importance, such as Leduc, Redwater, Fort St. John, Pincher Creek, and Jumping Pound. In cases like Turner Valley, Pembina, Lloydminster, Drumheller, and numerous others, credit for discovery must be given to a combination of money, venturesome spirit, and luck. In some fields oil has been discovered in a formation where it was not expected, and found missing in the main objective horizon. In other cases, instruments known as "doodlebugs", which are not recognized scientifically, have led to wells being drilled which found production. "Doodlebugs" may consist of a willow switch, a crystal ball, or combination of batteries, barbed wire and mysterious bottled chemicals. It takes all types to find oil!

In discussing the drilling of wildcat wells, remarks here will be confined to matters concerning exploration only, as the subject of drilling will be covered elsewhere in this program.

In drilling a well, a geologist is usually present to supervise sampling of rock cuttings, together with coring and testing of prospective producing horizons, as the well is carried down. Samples of rock cuttings from the bottom of the hole are continually being pumped to the surface in the drilling fluid. These samples are collected about every five to ten feet, washed clean of drilling mud, and examined under a microscope for determination of formation and the possibility of oil content. This information is recorded on what is known as the well log.

Considerable advances have been made in sciences such as geology, geophysics, and geochemistry to assist exploration.

When the well approaches or reaches a potentially productive strata, the geologist may have a core of the rock taken, the better to determine the character of the formation and decide upon the advisability of testing. If he thinks a production test is required, what is known as a "drill stem test" is made. In making a drill stem test the drill pipe and bit are pulled out of the hole, the bit is removed from the bottom of the drill pipe, and a "tester" is substituted in its place. The tester is run into the hole on the bottom of the pipe, and the zone to be tested is sealed off from the rest of the hole by a packing device. A valve in the tester is opened to allow whatever may be in the formation being tested to enter the drill pipe. In drill stem testing the pipe is run in empty, rather than full of fluid as in drilling operations, therefore whatever comes into the hole can be measured. If gas enters, it comes up through the drill pipe and is measured and sampled at the surface. If oil enters, it is measured as the drill pipe is pulled out from the hole, being held in the pipe by closing the valve in the tester before the pipe is pulled. If salt water enters, it is measured the same as in the case of oil. If oil is encountered, the hole may be completed as a producer, or drilled on to test lower horizons before completion. If water only is found, the well may be abandoned, or again deepened to test lower horizons.

Oil wells may range in depth from about 1,000 feet to over 20,000 feet. In Canada maximum depths thus far drilled are between 14,000 and 15,000 feet. Depths of from 5,000 to 10,000 feet are quite common. In general, drilling depths increase westward from Manitoba to the Rocky Mountains as the thickness of sedimentary rocks likewise increases.

Exploratory drilling costs in Western Canada may run from $25,000 to over $1,000,000 per well. The normal cost for a 5,000 to 6,000 foot well would run about $100,000. Once oil has been found and development gets under way costs can generally be considerably reduced.

In remote, inaccessible areas such as northern Alberta, north-eastern B.C., and in the Northwest Territories of western Canada, or, for example, in places in other parts of the world where off-shore drilling is required, such as the Gulf of Mexico, the Persian Gulf, and the California coast, costs may run even higher. Where a lot of gephysical work is required, and if these costs plus land acquisition costs are added to the drilling costs of a wildcat well, the total may run into several million dollars.

Acquisition of Mineral Rights

Having touched upon the origin of oil, and exploration methods, it may now be of interest to know something about how petroleum and natural gas rights are acquired for prospecting or development purposes.

In some parts of the world, such as the Middle East and South America, oil rights are entirely under the control of the governments. In such cases concessions for large areas are usually made by negotiation with the ruling powers. In other instances, the lands are put up for competitive bidding. Cash bonuses are generally required, together with a minimum gross royalty, or 50 per cent of the profits, whichever is the greater.

In the United States a great deal of the mineral rights were granted to the landowners at the time of original purchase of the surface from the Government. These lands, which are usually known as "freehold" or "fee" lands, may be leased to an oil company for, say, a ten-year period, subject to an annual rental of $1.00 per acre and a 12½ per cent gross royalty on any production obtained. Depending upon the attractiveness of a particular area, substantial premiums by way of cash bonuses, higher rentals, and/or higher royalties may be payable.

As a result of the widely diversified ownership of oil rights in the United States and the necessity of dealing with numerous landowners, rather than one, as where a government owns the rights, competition is very keen, and highly specialized land departments have been developed in most American companies. The same now applies in Canada. In such instances the job of obtaining title to sufficient property to permit development is indeed complex and costly. As an example, one of the tasks of the land man is to search titles, the ownership of which may include numerous people scattered all over the country, or in some cases all over the world.

In some countries when a company's concession runs out after, say, 25 to 99 years, all properties developed or otherwise, together with improvements, revert to the government at the end of the concession period, an example of which is Colombia, in South America. In some countries, after oil has been found and developed profitably, the government in power may decide that they do not like the deal they made with the company originally, and decide to demand a higher royalty or share of profit, or, as sometimes happens, confiscate everything, in return for which only nominal compensation is offered.

It is rather unfortunate for the Western world, which is at present the greatest consumer of oil, that the largest known reserves are located in countries in which our supplies could be cut off or made more difficult to obtain in the event of unstable political conditions. The dangers in the Middle East, with which you are all familiar, emphasize the seriousness of this situation.

The United States has long been the world's greatest producer and consumer of oil. During the past decade, however, her supplies have begun to lag behind demand, and she has become a net importer. Indications are that imports will increase during the next generation. In view of this, plus the fact that oil reserves in many countries outside the United States are vulnerable, Canada has, particularly since the Leduc discovery in 1947, been receiving increasing attention by American, and later by European oil companies, as well as Canadian.

In parts of Canada, mineral rights went to the landowner with the sale of surface rights until after the beginning of the century. Thus in Eastern Canada and the older settled parts of the Prairies, such as Manitoba and some parts of Saskatchewan and Alberta, the farmers owned their oil rights. An approximate breadown of Government owned and freehold rights by areas in Western Canada is as follows:

Area	Government	Freehold
Manitoba	15%	85%
Saskatchewan	70%	30%
Alberta	85%	15%
B.C.	100%	.....
N.W.T.	100%	.....
Indian Lands	100%	.....

In Western Canada freehold rights are usually leased in a similar manner as in the United States; that is, a ten-year lease with an annual rental and 12½ per cent royalty, with premiums sometimes being paid depending on the attractiveness of the acreage. If production is found within the ten-year period, and the lessee has lived up to the various drilling obligations, etc., the lease is normally renewable as long as production is obtainable.

In Canada oilwells are usually drilled on a 40 to 160-acre spacing pattern, or approximately ¼ to ½ mile apart. Gas wells are usually drilled on a 640-acre spacing pattern, or one mile apart. Therefore it may take from four to sixteen times as many oil wells as gas wells to develop and drain a field of similar size. The reason for this is that gas travels through the formation more easily than oil.

As already mentioned, the majority of oil rights in Western Canada belong to the Crown. Each province handles them on approximately the same general basis, but with certain local variations. As would be expected, before oil has been found in an area the terms are usually more generous than later on.

With competition becoming keener and keener, the costs of exploration and development are likewise getting higher, with the result that it is more difficult now for small companies to compete than formerly. The complex technical organizations that are now required in the business also make it difficult for the small companies.

Where large tracts of land are available, the provincial governments, or Federal Government in the Northwest Territories or on Indian lands, usually put them up for competitive bidding in the form of reservations or prospecting permits. Reservations are a sort of "hunting license", which gives an operator an opportunity of exploring an area and eventually selecting certain leases out of it. As a rule the operator has certain nominal rentals to pay during a reservation period, and certain work obligations, up to a maximum period of five to seven years. The work obligations and rentals usually increase during the later stages of a reservation term. When originally disposed of, cash bonuses running from a few dollars to a few million dollars may be received by the Crown, depending upon the size and attractiveness of the acreage involved. The amount of acreage obtained in reservation form may run from several thousands to several hundreds of thousands of acres. For the benefit of those who may not be familiar with acreage and distance relationships, a Township of land is 6 miles square, containing 36 sections, or 23,040 acres. At the end of, or any time during, the reservation term, the operator may convert into lease, proving he has complied with work and rental commitments. At this time one-half to two-thirds, or more, of the reservation may revert back to the Crown, the balance being obtainable in lease form if the operator has met his obligations.

Leases are usually square or rectangular in shape, and are generally taken out in an irregular, checkerboard pattern. The size of an individual lease may vary from ¼ section, ½ a mile square, to a 9-section block, 3 miles square. Leases may adjoin one another cornerwise, or be surrounded by corridors of a mile or more in width of lands which are retained by the Crown. Government leases normally call for an annual rental of $1.00 per acre, and gross royalties on a sliding scale basis ranging from 5 per cent to 16-2/3 per

(continued on page 1258)

Drilling and Completion Practice

A. S. Murray

Regional Drilling Engineer,
Imperial Oil Limited, Calgary, Alberta.

Read at the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June, 1957.

The author describes the main procedures for drilling oil wells and for their final completion, with particular reference to the practice in Western Canadian oilfields. Mention is made of costs and of materials used.

THE PRINCIPAL capital outlay of the Canadian petroleum industry is the expenditure which is made to drill and complete new wells. In 1956 more than 268 million dollars was invested in new Western Canadian wells. This represents over 60 per cent of the market value of the crude oil and gas production for that year. Back in 1947 when Imperial's Leduc discovery kicked off the present cycle of exploratory drilling, industry spent only 13 million dollars in its search for oil and gas. During the last 10 years, industry has poured over one billion dollars in direct drilling expenditure into new wells in Western Canada. This is of great importance to all of us working in the west, for it is estimated that 75 per cent of the money spent in drilling a well stays in the province where that well was drilled. The drilling industry has contributed significantly to the prosperity that some 3 million people in the Prairie Provinces are currently enjoying.

Our domestic drilling industry is made up of 125 drilling contractors and oil operators who own more than 325 rotary rigs. The output or gross business of these rigs is measured in terms of the total cost of the oil and gas wells drilled and completed, and not merely in terms of drilling cost alone which, on the average, is less than one-half of the total well cost.

Approximately 5,500 people are directly employed in drilling wells. If supply store and service company personnel are added to this total, since they are directly dependent on drilling, the total would be in excess of 8,000. It is significant that our drilling industry is truly a Canadian one, for 99 per cent of the people employed are Canadians.

The future of our drilling industry is a bright one. Western Canada is currently producing over ½ million barrels of crude oil per day. This production is expected to grow with the markets served. We can expect to produce and market something in excess of a billion barrels over the next five years. If we are to keep healthy, this oil must be replaced. We show every sign of doing just that. To maintain this position, however, industry will have to drill from 10,000 to 15,000 exploratory and development wells during the next five years.

We have already peppered this Western Basin area with over 17 thousand wells between 1947 and 1956. This represents in excess of 71 million feet. Despite these very large figures, we have hardly scratched the surface of this vast Western Basin area in our search for oil and gas.

During the past 10 years, drilling rigs have become as familiar a sight as the long standing and picturesque country grain elevator.

Let us go up on to a rig floor and examine the technique of how the rotary system of drilling works.

The Rotary System of Drilling

A schematic diagram of a rotary rig is shown in Fig. 1.

Drilling Rig

(A) There are rigs capable of drilling in excess of 22,000 feet. The deepest well in the world is 22,570 feet—located in Louisiana offshore area. It produces oil from a sand at 21,443 feet in commercial quantity.

(B) Rigs have been used with as much as 3,200 h.p. from diesel engines.

(C) Slush pumps used for mud circulation are rated as high as 1,500 h.p.

(D) Derricks are built that will withstand winds of 125 m.p.h.

(E) Derricks have been built to support loads in excess of 1 million pounds.

(F) Working loads may be as high as 400,000 pounds (i.e., loads actually run in hole; e.g., casing).

(G) The drilling industry breaks down rigs capable of drilling to 10,000 feet into pieces light enough for aeroplane or helicopter transportation —this has been done in the Persian Gulf, New Guinea, and Amazon basin.

(H) Industry is drilling from platforms in water 110 feet deep; for example, Lake Maracaibo.

(I) Ingenious offshore structures in the Gulf of Mexico permit drilling as much as 50 miles from shoreline but cost anywhere from 3 to 6 million dollars for the platforms alone, (designed to withstand 50-foot waves).

(J) Industry is drilling through the bottom of a converted L.S.M. ship with equipment that is designed for operations in 1,000 feet of water.

Working Floor

A rotary table with kelly is shown in Fig. 1. The drilling string is often rotated as high as 400 r.p.m. Generally, the softer the formation and the shallower the well depth, the higher the drilling string rotation. In hard formation a slow table speed is used.

Slips support the full load of the drilling string which at 10,000 feet weighs around ¼ million pounds. A 10,000-foot string of casing could weigh ½ million pounds.

Drilling Controls

The driller must study his control panel and from the many gauges decide what is occurring to his drilling string and what is happening at the bit. Some of the gauges used show mud circulating pressure, drilling string torque, drilling string weight, automatic drilling control, and drilling string rotational speed.

Blowout Preventers

There are two types—ram and stripper. The former has rams properly sized to close on the string of pipe in the hole; stripper type will provide positive shut-off on anything that is run in hole.

Drilling Bits

Soft formation; $177/bit; 9-inch—Frequently on bottom 30-40 hours carrying loads of 40-45 thousand pounds. Carries in many cases loads to 90 thousand pounds. Rotated at 400 r.p.m.; under some conditions down to about 30 r.p.m. Roller and ball bearings are used in drilling bits. As many as 964 bits may be used in drilling a 10,000-foot well.

Hard formation; $1,100/bit; 9-inch—For hard quartzitic sandstone and chert and lime digging. Such a bit can save 20,000 dollars on a well.

Factors Affecting Penetration Rate

The drilling rate of bits is governed by several factors:

(1) Formation
(2) Bit
(3) Mechanical
(4) Hydraulic
(5) Fluid properties

There is an optimum bit, speed of rotation, circulation rate, and weight on the bit for drilling each formation. Table speed, bit weight and circulation rate are linearly related to drilling rate if all of the factors affecting penetration rate provide for a clean hole at the bit. Knowledge of optimum drilling conditions for each formation will greatly reduce costs. For example, in the Leduc field penetration rate was trebled and bit consumption was more than halved when optimum bit weight, rotation speed, and circulation rate were established for each formation. Cost per well was reduced 30,000 dollars or an estimated savings on field development of 6 million dollars.

Function of Mud

Drilling mud is perhaps the most important part of the rotary drilling technique. The vast majority of muds may be classified as water-base, and consists of three parts:

(1) Liquid phase or water.
(2) Colloidal fraction which is the gelling portion.
(3) Inert fraction which consists of sand or other inert solids.

Wyoming bentonite, a pure form of montmorillonite clay is widely used with water to make drilling mud. Drilling mud is an exact science involving close control of viscosity, weight, water loss, gel strength, pH, and solids. Functions of drilling mud are to:

(1) Cool and lubricate the bit.
(2) Lift cuttings out of hole.
(3) Hold cuttings in suspension when not circulating.
(4) Establish a wall cake to hold formation in place.
(5) Exert sufficient hydrostatic pressure to prevent flow of water, oil, or gas into the well bore from formations drilled.

I have chosen to detail the rotary system of drilling because approximately 86 per cent of all the hole drilled is done by this method. Drilling with cable tools accounts for the other 14 per cent. This method has become increasingly "spot-type" in its application during the past 15 years falling from 33 per cent of the total footage in 1945.

Well Completion Techniques

What takes place when a hole is drilled to a reservoir rock that contains oil? A common misconception is that oil exists in underground pools or lakes and all that is required is to tap this pool through a cap rock and oil will start to flow to the surface. This is not the case, however. Oil accumulates in underground structures that are sealed by an impermeable barrier and occurs largely in porous limestone, fractured limestone and in sandstone. From the porosity standpoint, you might picture a sponge that is saturated with oil and is under pressure. Unfortunately there are very few ideal type reservoirs that will yield their oil freely. Considerable work is required in most cases to make oil reservoirs produce

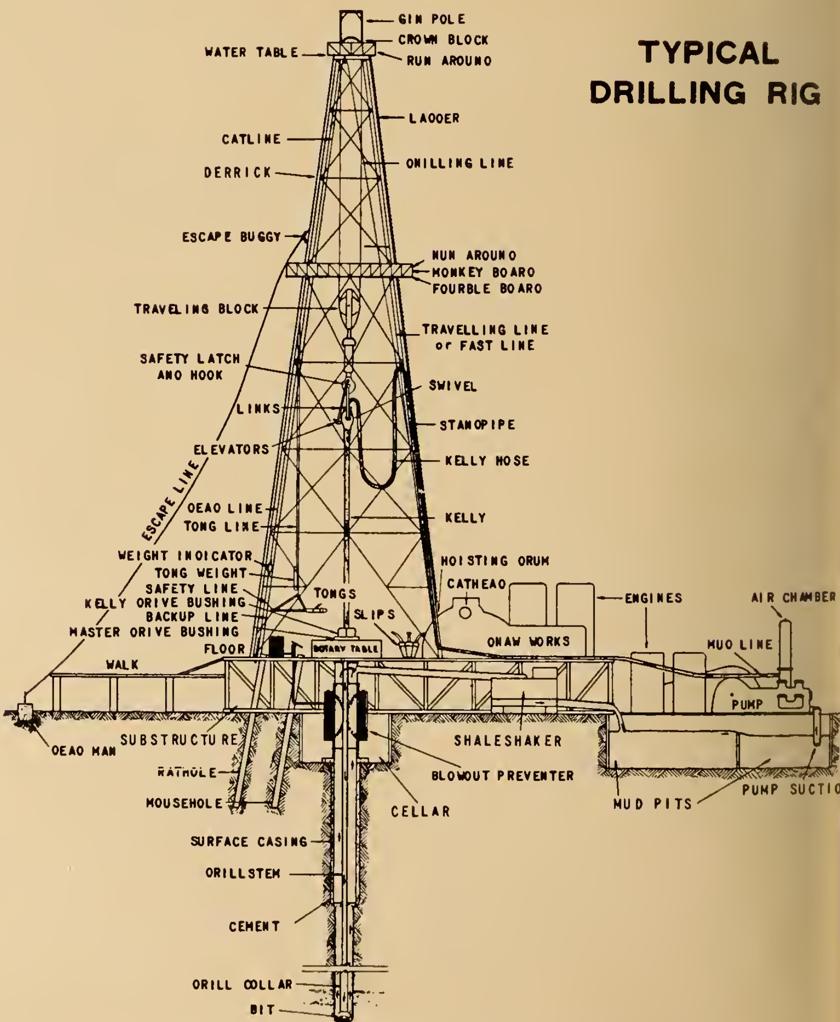


Fig. 1. A typical drilling rig, showing the main features.

Let us assume that a hole has been drilled to a proven production horizon and briefly consider completion methods that will bring oil to the surface. Completion methods fall into two main categories which are largely dependent on the nature of the reservoir rock and its contents.

(A) Casing is set through the producing section.

(B) Casing is set on top of the producing section.

Set Through Completions

"Set through" completions are adopted when the pay formation is incompetent and inclined to cave or fall into the hole. The method is also used where pay sands are divided, where pay sections are thin, where dual zone work is expected and where close control of the gas cap and/or water table is desired. Several techniques have been devised to overcome formation caving and the flow of sand into the well bore (Figure 2). These include:

(1) Cementing the casing string with a slotted screen on the bottom across the producing section so that no cement contacts the pay.

(2) Cementing the casing string so that no cement contacts the pay, perforating the casing and running a screen for sand production control. (Good where minor amounts of sand are produced.)

(3) Cementing the casing string so that no cement contacts the pay, perforating the casing, gravel squeezing, and running a screen. (Good for extremely incompetent formation producing sand.)

For the control and/or treatment of thin sands, divided sands, gas caps, and water tables, casing is set through the reservoir rock and perforated at accurately measured depths.

Set on Top Completions

"Set on top" completions are associated with competent reservoir rock. This method is adopted when the pay section has zones of poor vertical permeability, or where a sandstone reservoir rock is interbedded with bentonite or hydratable shale which will swell in the presence of water occurring from drilling mud or during a cement job, so that flow of oil into the well bore is inhibited. There are several advantages to this type of completion. It costs less than the "cased through" type. It avoids any cement contamination of the pay zone. It is possible to enlarge the well bore radius through the pay section if this is desirable, e.g. nitro shooting, or under-reaming. Sand production can be controlled by using screens, gravel packing, or under-reaming, gravel packing and screening combined.

Drilling In

I briefly mentioned previously that some pay formations are sensitive to the "drilling in" fluid or to cement. Cable tools or rotary may be used for drilling the reservoir rock. The cable tool method costs less, is less harmful to mud sensitive zones, more effective in lost circulation zones, and permits incremental deepening in thin pay sections. On the other hand, its application is limited to low pressure formations.

The rotary method is the most commonly used as it provides a greater flexibility of operations; e.g., well pressure control, faster completion, better cores, better electric logs. Its limitations, however, in many cases, are of considerable importance; e.g., permeability damage due to "drilling in" fluid, more costly, and loss of circulation hazard. Industry has conducted research into the development of fluids and techniques which will overcome formation damage while "drilling in". Some specialized "drilling in" fluids, which are in current use include water-base mud, oil-emulsion muds, salt water mud, oil-base mud, oil, air and gas.

Well Stimulation

Sometimes oil reservoirs require varying degrees of stimulation in order to make them produce at optimum rate. Well stimulation technique falls into two main categories:

(A) Large area penetrators

(B) Skin breakers

(A) Large area penetrating methods include nitroglycerine shooting, acidizing, and hydraulic fracturing. *Nitroglycerine* has been used only sparingly in Western Canada. It provides bore hole enlargement and there is no fluid effect on permeability, and it is not selective to a single fracture at the weakest bedding plane. Industry, however, has found that cleanout after a nitro job has been expensive. Its limited application to open hole completions, and the hazard to personnel and well equipment do not merit its widespread application.

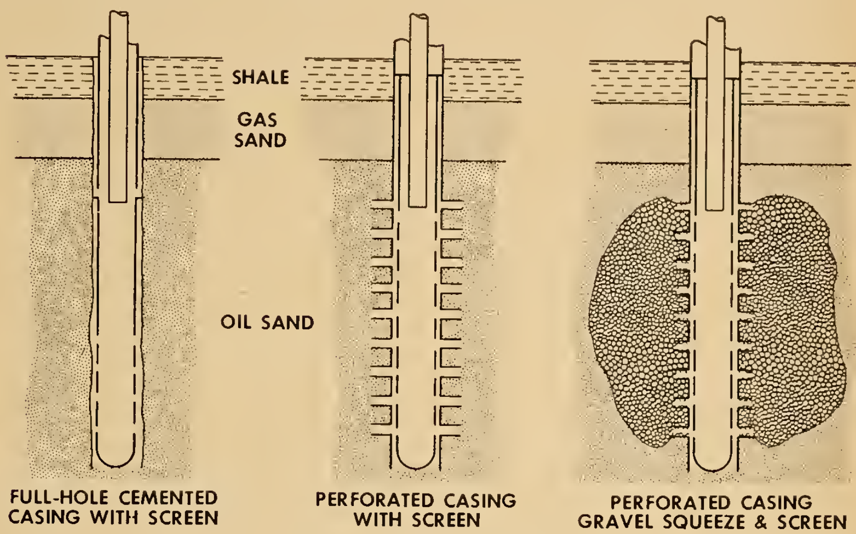


Fig. 2. Casting set through.

Acidizing has proven its merit as a large area penetrator in well stimulation for formations having appreciable calcareous content. The operation involves pumping acid into the formation under pressure. Moderate bore hole enlargement is possible, the technique is relatively inexpensive and it does clean out, enlarge and establish flow channels between vugs, fractures, and other channels.

Hydraulic fracturing has been the best large area penetrator technique ever developed in industry. This method of well stimulation has made many marginal fields of questionable economics a feasible operation. Hydraulic fracturing primarily is the application of fluid pressure to a desired section of the formation until rupture occurs. Continued pumping extends the breaks, thus creating new and larger flow channels to the well bore. Permeability is increased and higher flow rates result from the larger drainage area that is established. A propping agent (generally 20-40 mesh Ottawa sand) is pumped in with the fracturing fluid to maintain the channel open and so preserve the higher permeability. Hydraulic fracturing is characterized by a highly flexible procedure and its many benefits:

(a) Multiple or single fractures, combined advantages of fracturing and acidizing, wide latitude of sand carrier agent.

(b) Maximum effective area of stimulation.

(c) Maximum extension of inherent or induced fractures.

(d) Adaptation to either open hole or set through completions.

There are, however, several limitations worth mentioning. The method is relatively expensive. It involves cleanout of propping sand and it involves the use of high pressure on tubing or casing.

(B) Some reservoirs require only minor stimulation to induce optimum productivity. This involves largely the removal of mud filter cake from the well bore and cleaning out of the formation in the immediate vicinity of the well bore. Stimulation techniques of this nature are classified generally as skin breakers. Common methods in use included gun shooting, mud acid, surface active agents, jet acidization and marble shooting. All methods are relatively inexpensive. They improve permeability adjacent to bore holes that are blocked by mud solids, mud filtrates, emulsions and clay swelling.

Casing Perforating

A further consideration relative to well completion is that of perforating the casing. Two methods are available, jet or gun. Jet perforating has the advantages of maximum penetration, minimum cement shattering, minimum burring, and angle shooting. Gun perforating is cheaper than jets, and will produce a large, uniform hole. Careful investigation by industry during the past five years has shown that the type of fluid in which the perforating operation is carried out has a profound effect on well productivity. Selection of a perforating fluid depends on the nature of the reservoir rock, the drilling fluid that was used while "drilling in", the reservoir fluid, and pressure. Commonly used perforating fluids include oil-emulsion mud, oil-base mud, and oil.

Running and Cementing Casing

A further important consideration of well completion is the detailed planning that precedes all casing jobs. Casing strings are designed for tension, collapse, buoyancy, and burst factors with other modifications such as effect of buoyancy on compression and collapse. The methods followed in running, cementing, and landing casing may influence initial as well as ultimate well productivity, e.g. *when running casing:*

(a) The proper amount of torque is applied in making up joints to avoid leaks or failure in tension.

(b) A minimum dropping rate into casing to ensure that abnormal pressure surges are not set up which will the hole is set for each range of break down incompetent formation and cause loss of circulation when cementing.

(c) Scratchers and centralizers are fixed to the casing in the proper amount and spacing to adequately remove mud filter cake and centralize the string to reduce cement channeling.

Cement properties have been the subject of intensive investigation by industry during the past decade. Water loss, perforating characteristics, slurry weight, pumpability, and setting time are a few of the properties that have been investigated to obtain optimum conditions for oilfield use. A few years ago such material as bentonite, pozzolan, perlite, calcium lignosulphonate, and gypsum were unknown as additives to oilfield cements. In fact, a few years ago, casing strings were not even cemented in place.

Casing cementing technique has also been a research subject. One of the most important findings has been the necessity of continually reciprocating casing at least one full joint during the entire cementing operation. A further study that is important to the success of all casing cement jobs has been how to land the string in the wellhead. Research, and field experience has shown that cementing and landing the string in full tension reduces the possibility of breaking the cement bond between casing and well bore.

The final phase of producing reservoir oil involves running tubing inside the casing as the means of transporting oil to the surface. Dependent on well productivity and reservoir characteristics, the tubing is hung from the wellhead, open ended, or a packer is run with the tubing to seal off the annular space between tubing and casing or a pump is run inside the tubing and actuated by another strip of pipe called such rods. Time does not permit further elaboration of well completion techniques.

Drilling Costs

I mentioned in my introductory remarks that the principal capital outlay of the Canadian petroleum industry was the expenditure which is made to drill and complete new wells. Two hundred and sixty-eight million dollars were spent in direct drilling expenditure in 1956. Geology, weather, and terrain are the main factors influencing well cost. Often this cost has become very sizeable even before the bit has cut grass roots due to weather and terrain conditions. Well cost and depth relationships across Western Canada show the combined effect of these three factors and follow mathematically a power function ($y = ax^b$).

Some of the factors affecting drilling costs are summarized below:

1. Drilling costs in remote foothil

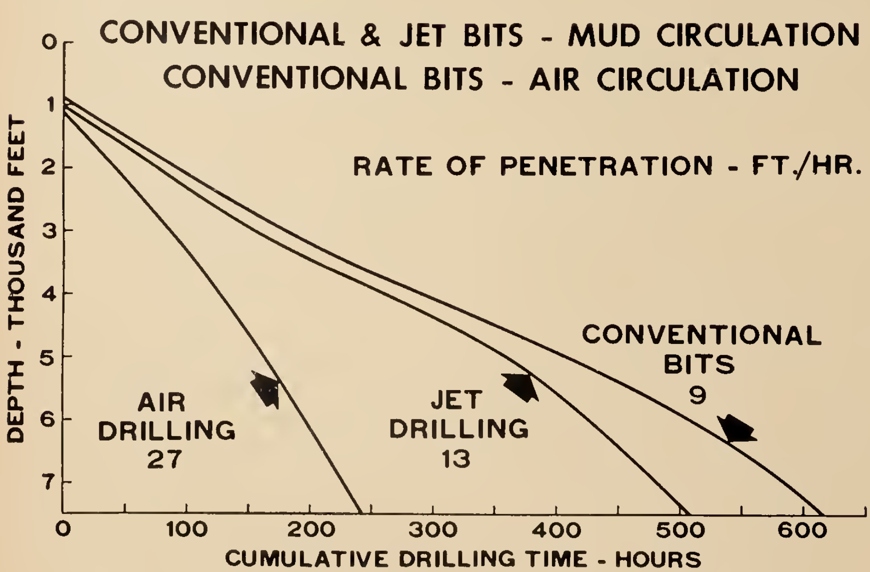


Fig. 3. Comparative penetration rate analysis.

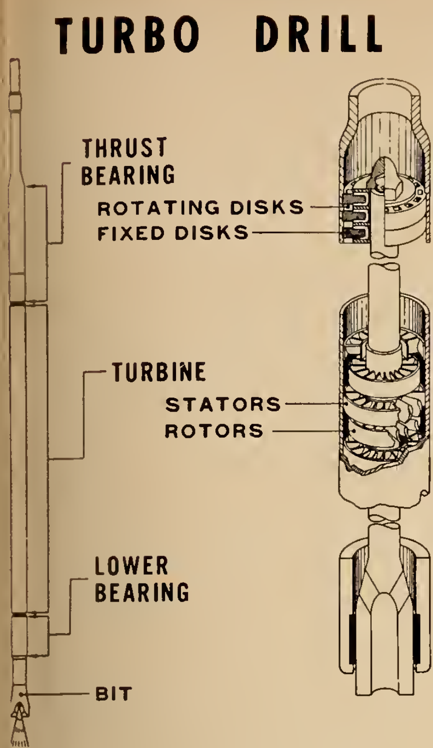


Fig. 4. Diagram of a turbo-drill.

locations may run over 1½ million dollars; remote muskeg locations may run just as high.

2. The time of year that drilling is done is important.

3. Cold weather is needed to drill in muskeg areas.

4. When spring thaw comes and drilling is still in progress, the rig must remain racked on location until the following winter before it can be brought out. Hence there is a loss of revenue due to this idle rig.

5. Drilling operations are round the clock, 365 days a year. Drilling operations do not shut down for extremes of heat or cold.

6. One hundred people may be involved in planning a wildcat location.

7. One hundred people are involved in drilling and completing the well without counting those needed to pay bills.

8. Transportation costs are high on emote wildcat locations—$300,000.

9. Road drilling and maintenance osts are high on remote wildcat loations—up to ½ million dollars.

10. Snow removal from 200 miles of bush is costly.

11. Twenty-six dollars to $120 per oot is the cost of Peace River and emote foothills wildcats; nineteen lollars to $55 per foot for Edmonton rea wildcats.

12. Fifty to 365 days drilling are equired on Peace River, deep remote wildcats; thirty to 100 days on Edmonton wildcats.

13. Average development field well takes 15 days to drill and complete at 5,000 feet.

Technological Improvements that are Reducing Drilling Costs

Previous mention was made that the ratio of drilling expenditure for new wells to income from crude oil and gas production was over 60 per cent. In view of the trend to deeper and costlier wells, indications are that this ratio will increase, unless industry can find ways to decrease costs, and drill fewer unnecessary development wells. I am pleased to say that technological improvements brought about by basic research in drilling have been responsible for maintaining drilling and well costs during the past six years at approximately 1950 levels. Some of these improvements include:

A greater knowledge of drilling hydraulics.

The wider use of chert bits for drilling hard rock formation.

The extended application of diamond drilling and core bits.

Improved drilling muds.

A wider use of air and gas drilling.

Advancements in formation evaluation and well completion technique, and improved rotary rig performance due to equipment research and product development.

Reducing Drilling Costs in Canada

I would like to briefly discuss three developments that may significantly reduce industry's drilling costs in the near future, slim hole drilling, air drilling, and turbine drilling.

Slim Hole Drilling

A slim hole is defined as one being 6 inches in diameter or less. Slim hole drilling is becoming of increasing importance as new techniques are developed and equipment made that will enable drilling and completion of small diameter holes. One of the problems that industry is trying to solve is how to drill slim holes as fast as full size holes. Investigations have recently shown that with improvements in 5⅝-inch and 6¼-inch drilling bits, this hole size can now be drilled at penetration rates equivalent to 9-inch hole in medium to soft formations. Small diameter holes save casing, mud, cement, and other items. Some wells have been completed with 4½-inch casing or 2⅞-inch tubing as production casing. Some of the wells cased with 2⅞-inch tubing only are pumpers which produce their allowables through hollow sucker rods. These practices have reduced well cost through a materials savings, e.g., there is a 7 per cent saving on a 4½-inch casing completion and 23 per cent on 2⅞-inch tubing as casing completion, based on a 3,500-foot well.

Equipment is currently available that will allow the performance of drilling and completion operations in slim holes equivalent to large size holes. As further techniques and equipment are developed, drilling and well costs may be reduced as much as 35 per cent.

Air Drilling

Industry has been drilling with compressed air or natural gas for over a decade and many economies have been reported in areas where dry formation has been drilled. For example, data from drilling experiments conducted in Pennsylvania where formations are dry to the producing interval, are of particular interest (Figure 3). Convention and jet bit drilling tests with mud circulation are compared with wells where air was used as the circulating medium. Penetration rate in the air-drilled wells was doubled compared with the jet bit test. Footage per bit was increased approximately 52 per cent. There are many other examples such as this, yet the fact remains that after 10 years of drilling with air or natural gas, industry has only been able to penetrate dry formation. Until recently, it was not known why air drilling was successful in penetrating dry formation at higher rates and with increased bit life as compared to mud circulation.

Basic research has been conducted to investigate the effect of overburden pressure, bore hole fluid pressure, formation fluid pressure and bit weight on rock drillability. Rock from the Canadian Plains area has been subjected to pressures ranging from atmospheric to 80,000 pounds per square inch. Results were consistent with other work, in that rock strength was found to increase with pressure although there was no correlation between these increases in strength and actual depth of burial. Investigations have also shown that some materials such as shale and limestone change from a brittle, easily shattered state to a plastic state as the overburden pressure increases. Equipment has been built to investigate the effect of physical changes that occur in rock under pressure on penetration rate at bottom hole conditions. Bore hole fluid pressure was noted to have a profound effect on drilling rate—as pressure increased, drilling rate decreased sharply. The results of laboratory studies were confirmed by field tests when it was shown that an increase of 250 p.s.i. over the hydrostatic pressure in the bore hole decreased drilling rate 65 per cent. Investigations of these types indicated that substantial increases in penetration rate could be made if bore hole pressure could be kept low. Air or natural gas circulation was the logical means of doing this.

From recent field investigations of air drilling operations in Western Canada, there has been developed a technique whereby wet formation can be drilled under certain conditions. This involves the injection of water and/or a surface active agent into the air stream so that air remains the primary phase. The method has been proven applicable to drilling competent formation producing water to the influx rate where there is no longer any penetration rate advantage of air over mud drilling. Industry's study of the air drilling technique is continuing and will continue until a satisfactory method of shutting off formation water is developed. When this is achieved, the full benefit of air drilling will be used by industry to effect greatly reduced drilling costs.

Turbine Drilling

One of the inherent disadvantages of our present system of rotary drilling is the inefficient transmission of power from the surface through several thousand feet of drill pipe to the bit. Up to 90 per cent of the power may be lost in overcoming the friction of the drill pipe on the walls of the hole. Industry has been trying to develop a workable turbo drill for over 50 years. The Russians have been successful in making one following eight years of intensive research (Figure 4). They make the following claims:

(1) A turbine drill has been developed with efficiencies up to 70 per cent.

(2) The drill can deliver three to five times as much power to the bit compared to the rotary system.

(3) Under normal or average drilling conditions, the turbo drill attacks the formation with eight or more times the power of the rotary system.

The turbine drill is essentially a hydraulic motor located in the drilling string just above the bit. A slush pump is the power source which drives the turbo drill. The drilling mud is circulated down through the drill stem and into the turbo drill where it passes through a series of alternate stators and rotors and is discharged in a conventional way through the water courses or nozzles of the bit. The stators are keyed to the outer shell and the rotors are keyed to the inner shaft which is directly connected to the bit. The passage of the drilling fluid through this turbine imparts a turning moment to the inner shaft and a downward vertical force which supplies a part of the weight on the bit for drilling. Additional weight for drilling is supplied by the drill collars.

There is considerable interest in this turbine drill. One company in the United States has imported 40 tools and these are currently being field tested. Future testing, mechanical development and improved economics may establish the turbo drill as a useful spot-type tool to supplement the rotary system, particularly in directional drilling and in drilling hard formation.

I have used slim hole drilling, air drilling, and turbine drilling as examples of the type of research and investigation which the drilling industry is conducting in its efforts to accomplish major well cost reduction.

Conclusions

In conclusion I would like to leave you with a few thoughts about the drilling industry:

(1) Drilling holes in the ground costs a lot of money. The revenue from crude oil and natural gas in Western Canada last year was 414 million dollars. The cost of drilling in Western Canada last year was 268 million dollars. Ratio of expenditure to income was over 60 per cent and represented the principal capital outlay of Canadian petroleum industry.

(2) Seventy-five per cent of the money spent for drilling wells stays in the province where the wells were drilled.

(3) Drilling research and field investigation is continuous in a worldwide industry that seeks technological improvements to achieve major well cost reduction.

(4) Get acquainted with our drilling industry, visit a rig on your next opportunity.

Oil Exploration

(continued from page 1252)

cent of the average daily production. An average gross royalty is approximately 12½ per cent.

As for the lands which revert to the Government after an operator has gone to lease, they are known as Crown Reserves, and may again be put up, all or in part, for the industry to bid for and explore or develop. The idea of the Crown Reserve is that the Government will have a chance of keeping one-half of any oil field that is fouynd, to dispose of such rights on a premium basis, and to date this policy has added materially to government revenues. It may be of interest to point out at this time that the Alberta Government has collected over $600,000,000 by way of royalty, rentals, and cash bonuses since the Leduc discovery ten years ago.

Most of the acreage in Western Canada, apart from remote sections in the Northwest Territories, is now held in reservation or lease form by oil companies, or by the Government as Crown Reserves. As a result there are many companies who do not have sufficient acreage on which to explore. Such companies, along with others who may be interested in exploring someone else's acreage, therefore often make a deal known as a "farmout". In a case of this kind, Company "A" may have the acreage directly from the lessor; Company "B" wishes to earn an interest in "A's" land by undertaking to do certain exploration or development work and possibly paying a cash bonus in addition. There are several types of interests obtained in deals of this kind. A common type of farmout is for "B" to earn a half-interest in certain of "A's" lands for doing certain work. After the half-interest has been earned, both "A" and "B" share jointly in cost and proceeds of development. In another case, "B" may develop "A's" land and pay an overriding gross royalty of 1 per cent of as high as 12 per cent, depending on the value of the acreage. In yet another type of deal, "B" takes over "A's" land and pays all operating costs, sharing net profits on a split basis, with "B" receiving 50 per cent to 75 per cent of the profits, and "A" receiving 25 per cent to 50 per cent. This type of arrangement is known as a "carried interest" deal.

Transportation of Oil

E. C. Hurd, M.E.I.C.
Administration Manager,
Trans Mountain Oil Pipe Line Company, Vancouver, B.C.

Read at the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June, 1957.

In common with the industry in other parts of the world, the Canadian oil producers have the problem of transporting crude and refined petroleum materials over very considerable distances to reach the main consuming markets. The author mentions several means of transport, but concentrates mainly on pipelines.

WHILE THE subject of my talk is transportation of oil, I propose to spend most of my time on pipelines and touch only briefly on the other forms of transportation, not with the idea of making any distinction in importance between the various modes of transportation, but because I am more familiar with pipelines, and because recently pipelines have seemed to become the "fair-haired boy" of the industry or "Peck's bad boy"—depending on who is talking! From the day the oil industry was born on the North American continent, transportation has been an important part of the industry. I shall not reopen the old argument as to whether the industry got its start in South Western Ontario or near Oil City, Pennsylvania, or some other place whose present day inhabitants may make such a claim, but certainly the floating of oil barges down Oil Creek in the early days was transportation—albeit a little nerve wracking and not eminently successful. Since that time advances in technology and know-how of oil transportation have kept pace with developments in the rest of the industry and show every indication of continuing to do so.

Highway transportation has grown from a very modest and what would seem to us now almost ludicrous beginning with horses or mules hauling wagons loaded with wooden casks containing at best a few hundred gallons, to the modern tank trucks that you are all familiar with—sleek, efficient, moving at some stage or other the bulk of the liquid petroleum products consumed on the North American continent.

Railways have always played a major role in transportation of all commodities. This is none the less true of petroleum and its products and in spite of the rapid growth of other forms of transportation in recent years, the railway has, and will continue to have for many years to come, an important place in the industry.

Events leading up to and following the closing of the Suez Canal have placed a great deal of emphasis on oil tankers. Before that time I believe few of us, other than those whose business kept them informed on world oil supplies, realized how much crude oil was moved by water and to what extent the world economy depended on the continuous movement of oil tankers.

For example, toward the end of 1956 there were in operation tankers totalling slightly more than 40 million deadweight tons, excluding the military and the Soviet Union, equivalent in carrying capacity to about 2,400 T2 tankers, each handling about 125,000 barrels of oil. More tankers are in various stages of construction and on order, including a relatively large number (89 at October 1, 1956) of ships larger than 40,000 d.w.t.

The largest built on this continent is the Niarchos tanker *World Beauty* of 42,000 d.w.t. and capable of carrying about 300,000 barrels of crude. The biggest in service so far is the Japanese built *Universe Leader* of 85,000 tons, with a capacity of the order of 600,000 barrels. Further than this, I understand the keel has been laid for a tanker of 103,000 d.w.t. for delivery in 1959.

A few years ago we thought of T2 tankers as big ships. Last fall some of these "big" T2's were used to lighten an 85,000 d.w.t. tanker before she could get into her dock in the San Francisco Bay area.

Figure 1 shows diagrammatically the relative sizes of a T2, a 40,000 d.w.t. tanker, an 85,000 ton ship, a 103,000 d.w.t. tanker and the Queen Elizabeth.

Most of the world's tankers are operating on long term charter, or equivalent, leaving a relatively small number available for the movement of spot cargoes and for short term charter. This makes charter rates extremely sensitive to the law of supply and demand. For example in the last 18 months we have seen rates for dirty tankers (i.e. tankers in crude oil or heavy fuel oil service) increase from 25 per cent under United States Maritime Commission rates in early 1956 to U.S.M.C. + 100 per cent and in one or two cases as high as U.S.M.C. + 200 per cent by early 1957, and then again in the last few weeks drop off to about U.S.M.C. —25 to 35 per cent. Some of the rates that have been reported as being paid over the past few years are shown in Fig. 2.

This feature plus the fact that wherever practical crude oil is moved by ship on a "back-haul", thus enjoying in one way or another the advantage of rates lower than those quoted, makes it virtually impossible to generalize on the quoted tanker rates at which oil from one source will be competitive with oil from a different source.

By way of comparison with figures on pipelines that are familiar to many of you, one ship like the *Universe Leader* carrying 600,000 barrels on a 60 days round trip from the Persian Gulf to San Francisco could handle 10,000 barrels per day (b/d) at a transportation charge (using 100 per cent of U.S.M.C. rates) of about $2.20 per barrel; and we are told that these big ships are designed to operate on a paying basis at rates of the order of U.S.M.C. - 35 per cent. and under certain conditions at even much lower rates.

I will not bore you with the old long-winded story of the first Canadian pipeline carrying whisky from Windsor to Detroit under the Detroit river during prohibition. Suffice it to say that although we have many new pipelines, pipelining is not new in Canada. However it is only in very recent years that this part of the industry has come into its own.

Many of the recent success stories of the Canadian oil industry start with the words, "Upon the discovery of the Leduc field in 1947 . . ." and so on. And though, before this time, there were a number of oil pipelines serving local areas the big push in this branch of the industry did not start until after that time.

Even before Leduc the Montreal pipeline and its connecting carrier Portland pipeline were built to receive tankers of crude at Portland, Maine, for delivery to the large refining centre in Montreal. One important advantage was the saving in ship time as compared with the long

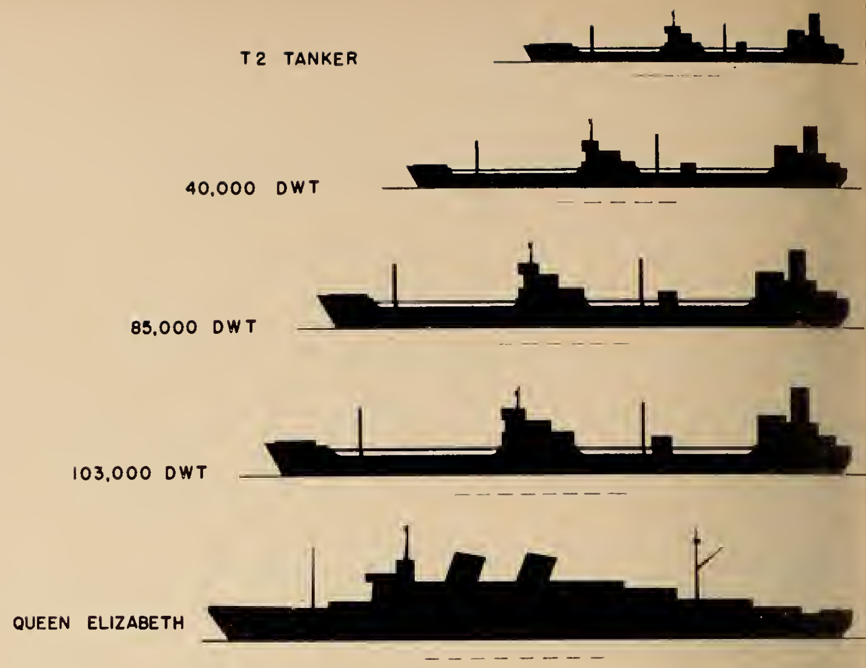
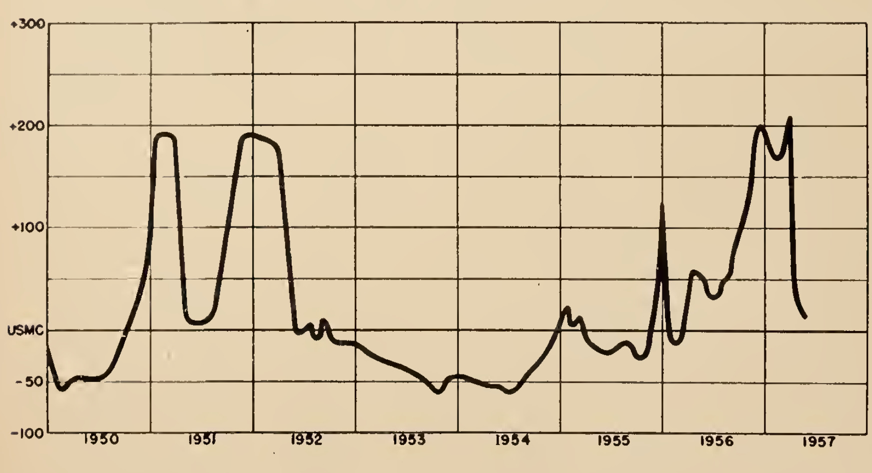


Fig. 1. Comparative tanker sizes.

trip up the St. Lawrence river at a time when tankers were in critically short supply. Then too, it provides year-round transportation and eliminates the necessity of building up large inventories of crude in tanks at Montreal sufficient to last over the winter period when the river is closed to navigation. Its original 12-in. line has been completely looped with 18-in. and last year it handled an average of over 200,000 b/d.

Interprovincial Pipe Line Company was formed in 1949 and by the fall of 1950 had completed a line comprised of 20-in., 16-in. and 18-in. pipe from the Redwater field through Edmonton, across Saskatchewan and part of Manitoba to the international boundary near Gretna, Manitoba, and from there by its wholly owned subsidiary, Lakehead,

Fig. 2. Average "paid" tanker rates (dirty).



to Superior, Wisconsin, on Lake Superior. This gave Western Canadian crude oil access to the Ontario mar-
crude oil access to the Ontario market by pipeline to the head of the Great Lakes and thence by tanker.
to navigation almost 5 months out of the year the last leg of this movement was also a summer-time operation. Thus the line was extended with 30-in. pipe from Superior to Sarnia giving year-round transportation to this important refining area. It now comprises 1,774 miles of line from Redwater to Sarnia — the longest single operating oil pipeline in the world. In addition some 1,000 miles of various sized loops have been added as well as connections to the numerous new oil fields in Saskatchewan and Manitoba and delivery connections to the refineries along the way.

The 1957 program calls for additional looping which when constructed will give two complete lines from Regina to Superior, Wisconsin, (24-in. and 16-in. Regina to Gretna, and 18-in. and 26-in. Gretna to Superior) as well as a 156-mile extension of the line from Sarnia to the Port Credit area just west of Toronto. Who knows, maybe the next leg will reach Montreal. Throughput in 1956 averaged 266,000 b/d for a total of a little over 97 million barrels.

Trans Mountain, incorporated in 1951 and in operation in late 1953 with a 24-in. line from Edmonton to Burnaby, near Vancouver, and an initial design capacity of 75,000 b/d,

·hich was increased to 120,000 b/d efore the original construction was omplete, afforded the first outlet for Canadian crude to the west coast.

In the case of both of these companies, expenditures of nearly $100,000,000 each were made at a time when there was no guarantee that nough oil would be shipped through e lines to pay direct operating expenses, let alone amortization of the nvestment and a reasonable return the shareholders. Such courageous lanning, sparked by a firm belief the future of Alberta crude oil roduction in particular, and the Canadian oil industry in general, has placed across Canada the backbone of transportation for what is now one of its largest industries.

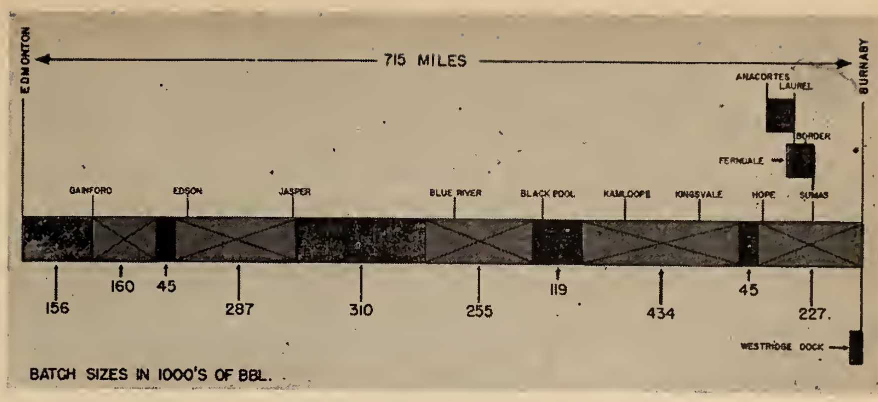


Fig. 3. Batch sheet.

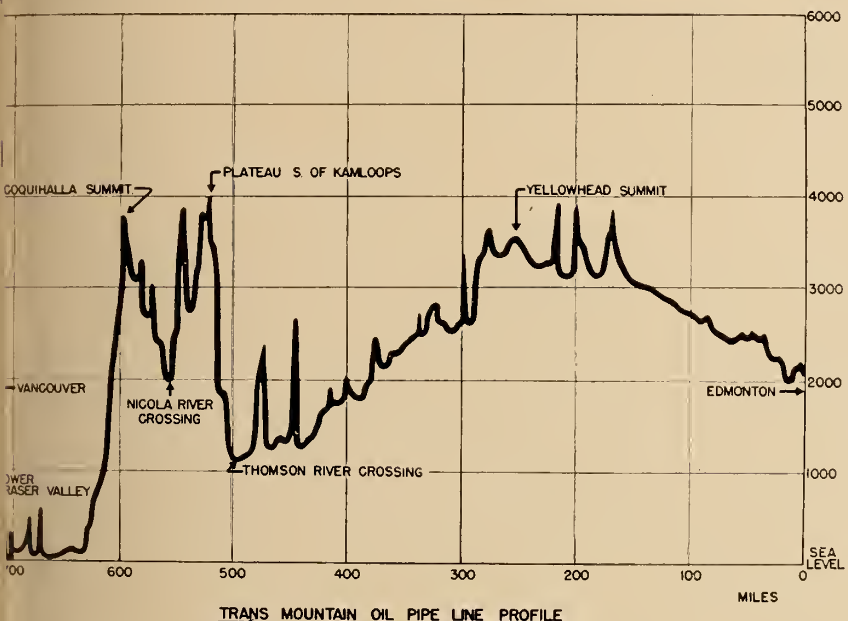
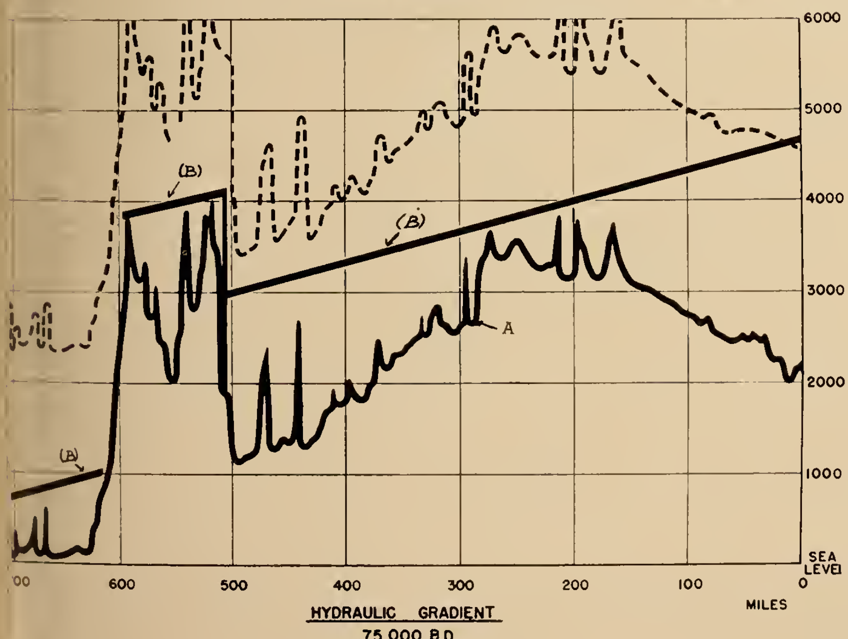


Fig. 5. Hydraulic gradient at 75,000 b/d.

Fig. 5. Hydraulic gradient at 74,000 b/d.



Trans Mountain's growth, while not so great in miles of line, has been just as spectacular in terms of quantity of oil transported. The line was extended to two new refineries in the State of Washington and on January 1, 1956, the first of a long line of tankers was loaded with Alberta crude for delivery to California. During the year a couple of spot cargoes were even loaded for Japan and France. An expansion program now under way will bring the capacity of 240,000 b/d by late summer of 1957, and possibly to 300,000 b/d by next year. Potential ultimate capacity is well beyond this figure. Deliveries in 1956 totalled 47,250,000 barrels for an average of 129,000 b/d.

In the first quarter of 1957 these two lines delivered an average of 440,000 b/d, a quantity equal to the daily consumption of all the refineries in Canada at the end of 1953.

No less important than these east and west trunk lines are the gathering systems and shorter trunk lines which feed them.

Each trunk line has a few problems unique to its own terrain and climate, but most of the engineering and operating features are common to all trunk lines, so if I deal with the Trans Mountain system from here on it is because it is the one I am most familiar with and in any case the salient features will be the same.

The oil is delivered into a Trans Mountain tank in Edmonton, which has previously been jointly gauged, and when the delivery is completed the tank is again gauged and sampled jointly by representatives of the delivering carrier and Trans Mountain. From certified tank capacity tables the quantity received into the tank is calculated, corrected for temperature and water and sediment and this information is recorded on a "run ticket" witnessed by both representatives.

This run ticket then becomes the legal document, not only for the payment of transportation charges from the field to Edmonton, but also for the transfer of custody of the oil from one company to another.

At the appropriate time in the pumping schedule this tank is opened to the suction side of the electric-motor-driven booster pumps which send it on through heat exchangers to the suction side of the main station pumps, driven through speed-increasers by 500 r.p.m., 2,000 h.p., 8-cylinder, gas-fired diesel engines. The engine jacket water is cooled by being circulated through the other side of the heat exchangers.

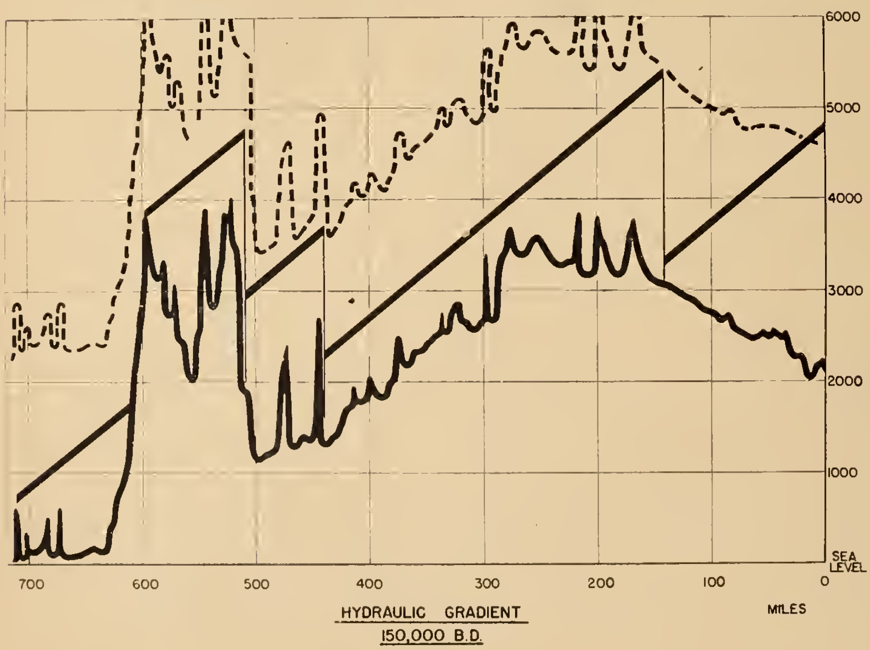
In the Edmonton station the four pumps are 5-stage centrifugal, run in parallel, each capable of pumping 75,000 b/d at a discharge pressure of about 1,100 psi. The station is normally operated on automatic flow control with instruments provided for apportioning the hydraulic load equally amongst all of the operating units as well as overriding alarm and shutdown devices to protect against too high discharge or too low suction pressures. Protective devices are also provided against such faults as low lubricating oil pressure, high pump-case temperature and overheated bearings. The discharge pressure required for the desired flow rate is dependent on the viscosity of the oil at its flowing temperature, the size and length of line to the next station (hence the friction loss), the difference in elevation between the two stations, and the suction head to be overcome at the next station.

Trans Mountain started operating with tanks "floating on the line". That is, one station pumps into open storage tanks at the next station and that station takes suction from these tanks and so on. However this was soon changed to operation on "tight line" where the upstream station pumps directly to the suction side of the following station. This requires more elaborate control equipment but the advantages are many; the oil is kept inside the pipe instead of being admitted into tanks, so evaporation losses are reduced; the mixing of one type of crude with another in the tanks is eliminated; and, by adjusting up or down the suction pressure of an intermediate station, a substantial portion of the hydraulic load can be transferred from one pump station to another.

The oil is pumped on, from one station to another, finally arriving in one of the stock tanks at the terminal on Burnaby Mountain some 500-600 feet above sea level. Here deliveries are made to one of the three connected refineries through their own 10-in. and 12-in. pipelines, or through a 24-in. line to ships at the Westridge Dock in Vancouver Harbour. Because of the differences in elevation all these deliveries can be made by gravity. The tanks are provided with individual lines to a central manifold so that the main line stream can be received, and deliveries can be made to three refineries and one ship all at the same time. As before, the oil in a tank is gauged and a representative sample is tested by both interested parties and run tickets made out covering the transfer of custody of the oil. You will notice that I have not said that oil is bought and

Fig. 6. Hydraulic gradient at 120,000 b/d.

Fig. 7. Hydraulic gradient at 150,000 b/d.



sold on the basis of these tickets. Except for a small amount of "allowance" oil as provided by the tariff all the oil in the system is owned by the various shippers and is only in the custody of the carrier.

As in Edmonton the tanks are all provided with automatic gauging devices with remote instruments, reading to the nearest ⅛-in. located in the control room. With proper installation and maintenance these remote reading gauges are as accurate as hand gauging but so far have not been generally accepted for custody transfer purposes.

Positive displacement meters, on the other hand, have been the subject of extensive study for a long time by a special sub-committee of the American Petroleum Institute and their use for this purpose is growing steadily.

So far we have been talking about crude oil moving through the pipeline without reference to what kind of oil it is. Actually most trunk lines handle several types of crude oil and if a description of the job that a crude oil pipeline is expected to do had to be put into a few words it would probably be, "to get the right amount of the right kind of crude to the right place at the right time". This is where the dispatcher comes in.

He is in almost constant contact with representatives of the shippers. About a week before the end of each month they tell him, by grades and consignees, how much oil they wish delivered during the following month.

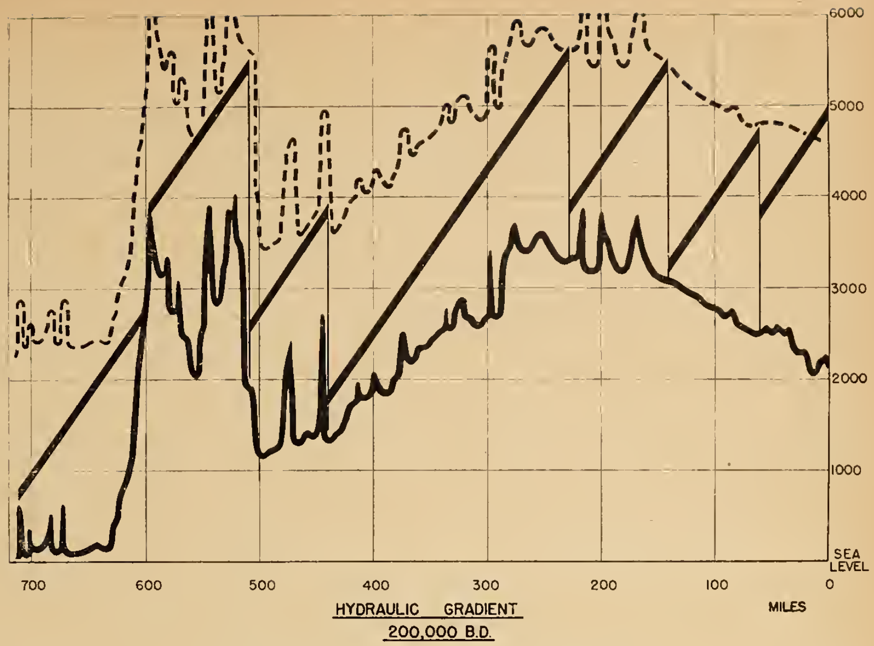
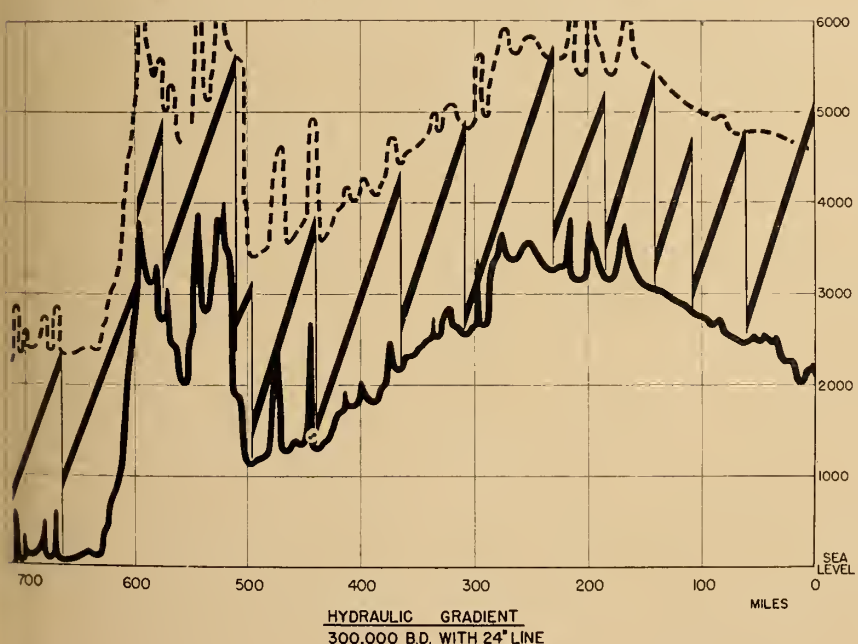


Fig. 8. Hydraulic gradient at 200,000 b/d.

With this information from all the shippers he works out his pumping schedule. It is a rather complicated and lengthy job, but once he has it worked out all he has to do is lean back and watch it run for a month. That is what he tells himself is going to happen some day—if he lives long enough! However, in practice, just about the time he gets it all worked out something happens—a refinery has an unscheduled shutdown (I understand that does happen sometimes) or it wants to run an extra 10,000 barrels per day (we like that much better), or there is a road ban and the gaugers can't get to the batteries in a particular field so we are short of that kind of oil—and the whole schedule has to be worked over again. So if you meet one of these dispatchers and he is talking to himself, don't worry about it, it is just one of the occupational hazards.

Figure 3 shows a typical arrangement of batches of different oils in the line from Edmonton to Burnaby. The 24-in., 715-mile line shown contains a total of a little over 2,000,000 barrels of oil.

Fig. 9. Hydraulic gradient at 300,000 b/d with 24-in. line.



We are often asked, "How do you keep the different oils separate What do you put between the batches to keep them from mixing?" The answer, of course, is: nothing. As long as the velocity is high enough to be well within the range of turbulent flow, the turbulent front is quite resistant to mixing. The velocity at which the flow changes from "stream line" to "turbulent" varies with the viscosity of the oil at flowing temperature. An average condition in Trans Mountain's 24-in. line would give turbulent flow above a velocity of about 0.4 f.p.s. equivalent to a pumping rate of 18,000 b/d. At this rate, or higher, and with normal batch sizes the adverse mixing of adjoining batches is as little as 0.5 to 0.7 per cent.

Since the cost of the pipe itself is a major portion of the cost of building a pipeline the choice of material for the pipe is most important. It must have a uniform wall thickness, it must be readily weldable and it must have as high a yield strength as practical to allow minimum thickness that will be safe for the designed operating pressures. For instance, at today's prices an extra ⅛ in. in thickness on a 24-in. line adds about $25,000 per mile to the cost of the pipe.

The pipe most commonly used for oil trunk lines today is API 5LX, Grade X52. This is manufactured by forming steel plate and welding in the normal way and then cold expanding which raises the yield strength of the steel from about 40,000 psi. to 52,000 psi. This type of manufacture necessitates special welding technique but this disadvantage is far outweighed by the cost advantage of the thinner wall pipe.

Many features of pipelining are similar to those of process industries but two things stand out, particularly, as being different from an engineering standpoint. For one thing it is normal in a pipeline to allow pressures which will stress the pipe steel up to 65 per cent of its yield strength whereas in refineries, for instance, factors of safety of 5 to 1 or even higher are normal. The other point is that, in most process industries, differences in elevation between parts of the plant are not significant in designing for pipe strength. A look at the profile of Trans Mountain's main line will illustrate the magnitude of the effect of elevation on pipeline design. (Fig. 4).

Starting at Edmonton at an elevation of 2,300 feet the line climbs more or less gradually to Jasper and the Yellowhead pass at 3,700 feet, then hits a low point of 1,100 feet under the Thompson river at Kamloops. In a very few miles out of Kamloops it climbs again to nearly 4,000 feet, down again to 1,800 feet under the Nicola river and reaches the final high point at the top of Coquihalla pass at an elevation of 3,700 feet. From here it drops, in less than 30 miles to within 100 feet of sea level in the lower Fraser Valley and finally up to 500-600 feet at the Burnaby terminal.

With the line standing full of oil and not flowing the static head difference between, for instance, the top of Coquihalla canyon and the Lower Fraser Valley is about 3,600 feet, equivalent to 1,300 psi., with proportionate static head differences elsewhere on the line.

However the line is not making any money while it is just standing there full of oil so let us have a look at it under flowing conditions. The original design contemplated a capacity of 75,000 b/d when pumping Redwater crude at 40 deg. F., that is, oil of 0.85 specific gravity and a viscosity of 115 S.S.U. Two pump stations are required, one at Edmonton, of course, and one at Kamloops (Fig. 5). The scale on this chart is proportional to 20 miles per inch horizontally and 500 feet per inch vertically, and the profile has, of course, been greatly oversimplified. The solid line (A) is the profile of the pipe. The dotted line at the top is the pipe strength curve, the difference between these two lines representing, in terms of feet of head, the allowable stress in the pipe at any point. The line (B) is the hydraulic gradient when flow is at the rate of 75,000 b/d. This represents a friction loss of 3.4 feet of oil or 1.23 psi., per mile.

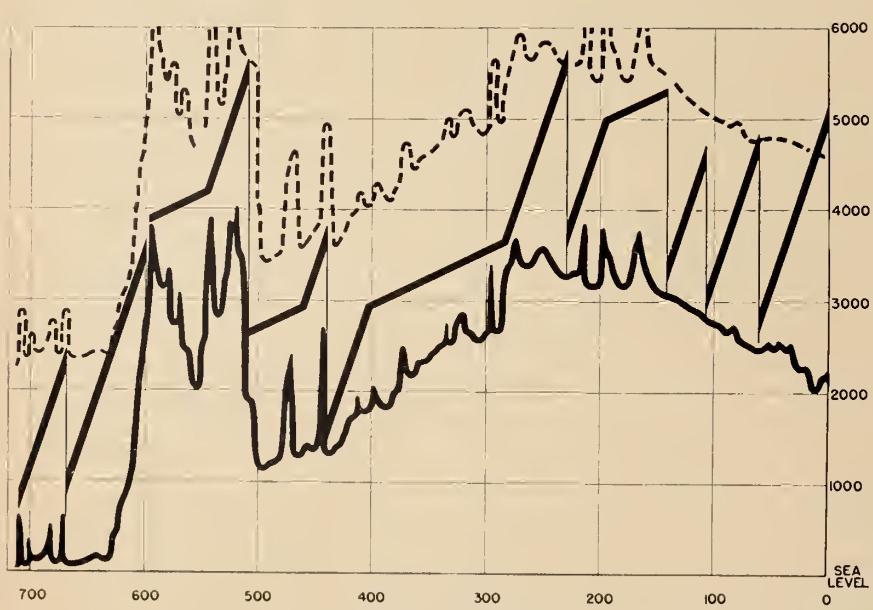
In order for the oil to flow at this rate the hydraulic gradient must be above the pipe profile and to be safe it must be below the pipe strength curve. So what do we have to do to raise the rate up to, say, 120,000 b/d? At this rate the friction loss is 7.4 feet per mile, the hydraulic gradient is steeper and it will not reach from Edmonton to Kamloops without exceeding the strength of the pipe. So we put in a station at Edson, and the gradient is as shown in Fig. 6. A rate of 150,000 b/d requires one more station at Blackpool. (Fig. 7), and 200,000 b/d calls for two additional stations at Gainford and at Jasper. (Fig. 8). By this time the friction loss has climbed to 18.3 feet per mile.

To go from a capacity of 200,000 b/d (which is Trans Mountain's present situation) to 300,000 b/d by the addition of stations alone would require the installation of seven more stations (Fig. 9). This is about the practical limit of gaining extra capacity on a 24-in. line by the addition of pumping stations alone and if 300,000 b/d were considered to be the ultimate need of the line this would be quite a practical course to follow.

If, however, capacities beyond 300,000 b/d are foreseen, then weighing the higher capital cost of looping against the higher operating cost of numerous stations indicates that the more practical approach is to start looping the line. Again using Trans Mountain as an example, that is the approach taken this year whereby the installation of two 50-mile loops of 30-in. pipe, and one permanent and three temporary stations, will increase the capacity to 240,000 b/d by August of this year. The addition of another 175 miles of 30-in. pipe next year, and the retirement of the temporary stations could raise the capacity, if needed to 300,000 b/d (Fig. 10), and if carried through eventually to complete new 30-in. line from end to end would raise this to over 600,000 b/d

(continued on page 1272)

Fig. 10. Hydraulic gradient at 300,000 b/d with 24-in. line and partial 30-in. loops.



Gathering and Processing Natural Gas

J. M. Dillon

Manager, Gas Department,
Shell Oil Company of Canada Limited, Calgary, Alberta.

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NATURAL GASES are mixtures of organic compounds, principally hydrocarbons, and may contain inorganic constituents such as nitrogen, hydrogen sulphide, carbon dioxide and water. A feature of a typical high pressure gas field is the production of light oil, or condensate, together with relatively large volumes of gas. The major component of the gaseous phase is normally methane, the lightest of the paraffin hydrocarbons, with the heavier hydrocarbons and inorganic gases being present in lesser quantities. Propane and heavier hydrocarbons are condensable at moderate pressures and normal temperature and are designated as condensables or volatile products of natural gas. Propane and butane are well known as fuels and the pentanes and heavier fractions form natural gasoline. Carbon dioxide and hydrogen sulphide are acidic gases and if present in appreciable quantities the natural gas is classified as sour.

Analyses of gas from Alberta fields are presented by Table I. Contents are expressed in mol % which is equivalent to volume % for gases and, for the condensable hydrocarbons, in Imperial gallons per 1000 cubic feet. The analyses are for separator vent gas; that is the liquid hydrocarbons or condensate have been removed by physical separation. Gas "A" is rich in volatiles. It is theroretically possible, although uneconomic, to extract a total of 1.43 gallons of volatiles from 1000 cubic feet of the gas. This is sweet gas as there is no hydrogen sulphide present and only a nominal amount of carbon dioxide. Gas reserves of similar composition are the Viking-Kinsella, Cessford, and Medicine Hat fields in Alberta. Analysis "B" is also representative of many large reserves in Western Canada. This gas is lean, containing only one third as much volatiles as "A", and is sour as 3.1% hydrogen sulphide and 6.1% carbon dioxide are present.

Type "C" contains both more volatiles and acid gases than does type "B" gas. Very large reserves of similar composition have been discovered in Alberta; for example Pincher Creek. Gas "D" is very lean, containing only 0.15 gallons of volatiles per 1000 cubic feet, and extremely sour. Such high contents of hydrogen sulphide had been rarely encountered throughout the world before the discovery of substantial reserves of such gas in the Calgary district. Accumulations of gas of type "D" represent large reserves of sulphur as hydrogen sulphide.

Most raw natural gas requires processing prior to sale to remove impurities and to recover valuable by-products. Gas and associated liquids are brought to a central plant by means of common or "two phase" gathering lines. Liquids are separated from the gas and then the gas is processed to remove sulphur compounds, carbon dioxide, volatiles and water. Sulphur is a by-product.

Field Gathering

High pressure gas-condensate reserves are the chief source of supply for large scale gas pipeline projects. Condensate is produced with the gas and provisions must be made to collect this valuable product for marketing. Current practice is to utilize common or two-phase gathering lines to bring gas and condensate from the wells to a central point for separation and processing. By centralizing condensate separation, storage and shipping facilities investment and operating labour costs are less than if individual separators and storage tanks were provided at each wellhead. However, before a two-phase gathering system can be employed the field operators and royalty owners must agree to operate the field as a unit.

Hydrate formation and plugging of lines and equipment is the major problem associated with the operation of high pressure field gathering lines. Natural gas hydrates are crystalline compounds of light hydrocarbons with water and look like firm snow or can be in the form of transparent ice crystals. Hydrates may form at temperatures above the freezing point of water, the critical temperature depending upon the gas composition and pressure. Formation of hydrates is promoted by turbulence occurring at pipe fittings, bends and changes in line size. Conditions at flow restrictions are favourable for hydrate formation because as a result of expansion the gas may be cooled below the critical temperature. Hydrates accumulate in line restrictions or slopes and eventually may form a solid plug. Variation of critical temperature with pressure and gas composition is illustrated by Fig. 1. Inspection of these typical curves reveals that the critical temperature increases with pressure. Curve I is for pure methane whereas Curve II is for a gas containing heavier hydrocarbons. Generally speaking, the critical temperature is higher for richer gas. Curves such as these can be used to predict hydrate formation for design purposes.

Hydrate formation is combated by dehydration, heating or inhibition. Dehydration of the gas so that the dewpoint is lower than any temperature encountered in the gathering system will avoid condensation of water and thus eliminate hydrates as liquid water must be present for hydrates to form. Heating may be used to keep the temperature above the critical temperature. Inhibitors such as alcohol depress the critical temperature and will melt hydrates which have already formed. Curve III of Fig. 1 is a plot of critical temperatures for the same gas as the Curve II but inhibited with a 10% aqueous solution of methanol. Comparison of the two curves shows that the critical temperature for this particular gas has been lowered by 8°F. Inhibition is normally used only in emergencies to melt hydrate plugs but, if adopted for continuous use, glycol is usually the inhibitor used since the glycol can be recovered and used again. In most cases either dehydration or heating are more economical than inhibition.

The most certain method of eliminating the hydrate problem is to dehydrate the gas. This may be done by passing the gas through a vessel containing a bed of solid desiccant, e.g., silica gel, or by contacting the gas with glycol in a bubble-plate column. Heating is also an effective method of hydrate prevention in field gathering systems where gas is transported short distances. In a typical operation the gas is heated prior to throttling from wellhead to line pressure and the main gas stream flowing through the gathering line is reheated at each well to compensate for heat losses in the line. The danger of hydrates forming is most serious during the winter as the ground temperature at the depth at which the gathering lines are buried may be as low as 30°F., about 40°F. below the critical temperature. Sufficient heat must be added at each well so that the gas is still above the critical temperature by the time the next line heater is reached. The line heaters are indirect-fired with coils immersed in a water bath.

Lines are usually buried with 3 feet of earth cover for physical protection and thermal insulation. For protection against external corrosion, the pipe is wrapped with glass fibre cloth and coated with enamel or, alternatively, wrapped with adhesive plastic tape. Recent practice is to guard against corrosion at defects which invariably develop in the coating by cathodic protection using rectifiers or sacrificial anodes. Vaults are provided at one-mile intervals to permit isolation of sections and access to the line for testing, cleaning, and inspection. River crossings are made by means of suspension spans or by weighting the pipe and laying it in a trench in the river bed.

At a central point in the field, usually at the processing plant, the condensate is separated from the gas. The condensate may be sent directl to storage or first processed to remove the more volatile or "wild" fractions. Except in rare cases the raw gas from the separators must be processed before sale.

Liquid flow in a two-phase system is erratic because liquids may accumulate in line depressions and periodically carry over or "slug" into the central separation station. Liquid flow characteristics change abruptly with minor variations in gas rates making slugging a serious problem when flow rates are being adjusted. To avoid carry-over of condensate into the gas processing plant it is necessary to install oversize separators to handle sudden surges of liquids. Separators are often of the double - barrelled type (Fig. 2). Liquids and entrained mist are separated from the gas in the upper barrel and accumulate in the smaller lower barrel.

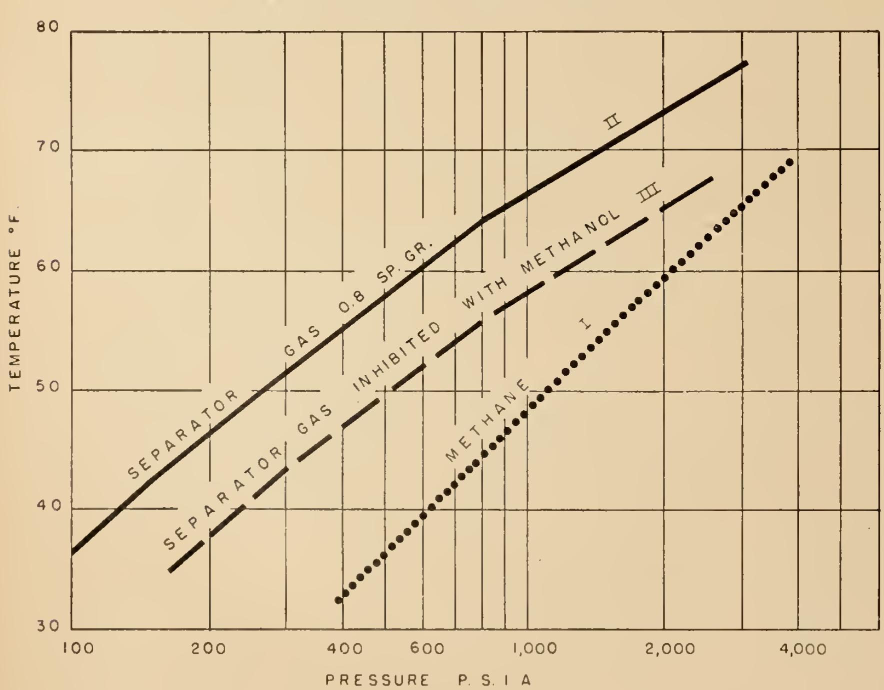
Reasons for Processing Gas

Distributors require natural gas of a certain quality for trouble-free op

TABLE I—SEPARATOR GAS ANALYSES

	A	B	C	D
	MOL %			
METHANE	84·8	84·8	72·6	52·1
ETHANE	6·0	3·9	5·8	0·7
PROPANE	3·2	1·0	2·1	0·2
ISO-BUTANE	0·7	0·3	0·3	—
N-BUTANE	1·2	0·3	0·8	0·1
PENTANES +	0·7	0·5	0·4	0·2
NITROGEN	3·1	—	3·5	1·8
CARBON DIOXIDE	0·3	6·1	5·1	10·1
HYDROGEN SULPHIDE	—	3·1	9·4	34·8
TOTAL	100·0	100·0	100·0	100·0
	IMP. GAL. / 1,000 CU. FT.			
PROPANE	0·73	0·22	0·48	0·05
BUTANES	0·48	0·16	0·28	0·03
PENTANES +	0·22	0·17	0·14	0·07
TOTAL	1·43	0·55	0·90	0·15

Fig. 1. Gas hydrate equilibrium curves.



eration of their own systems and to ensure the consumers of a continuous supply of uniform performance fuel. Contracts between the distributor and producer set strict limits on the composition and properties of the gas and the majority of reserves require processing to meet these contract terms. A typical gas contract specifies a maximum hydrogen sulphide content of 1 grain per 100 cubic feet, minimum heating value of 1000 B.t.u. per cubic foot, and hydrocarbon and water dewpoints of not more than 15°F. at 800-900 psig. The reasons for the restrictions of hydrogen sulphide are that: this gas is toxic; sulphur dioxide is formed when the gas is burned, producing a disagreeable odour; and hydrogen sulphide is corrosive to pipelines and associated equipment. Minimum heating value is specified to restrict the content of non-combustible gases such as nitrogen and thereby limit the size of lines and compressors needed to transport energy at a given rate. Low hydrocarbon and water dewpoints are required to avoid condensation in pipelines. Presence of liquids increases pressure drop and consequently reduces the capacity of the lines. Water contributes to internal corrosion of pipe. Condensed liquids could accumulate in pipelines and distribution systems, periodically carrying over into pipeline compressors and consumers' heating equipment with serious consequences.

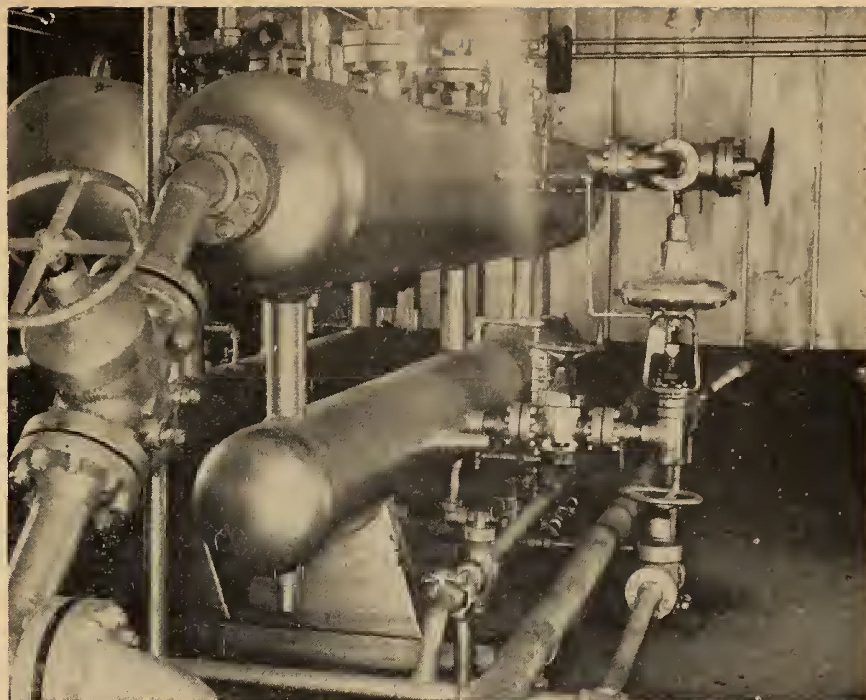
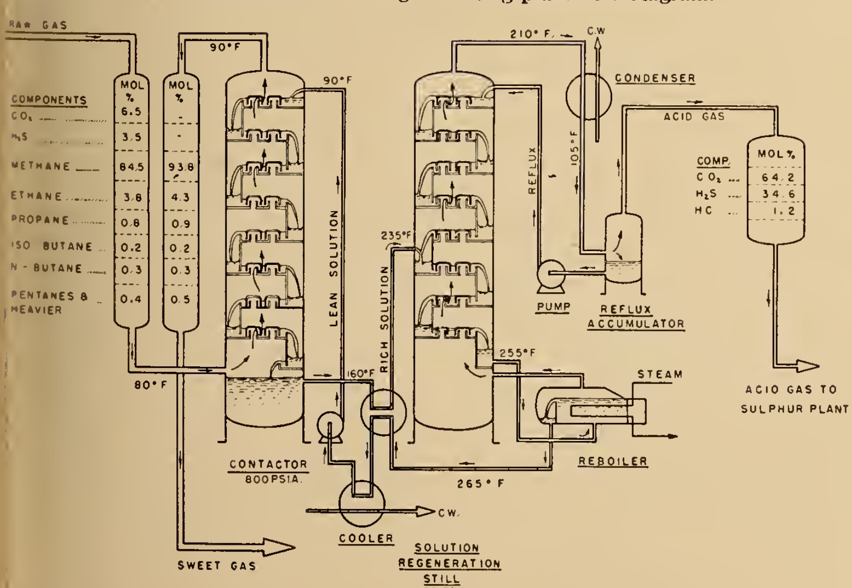


Fig. 2. Plant inlet separator.

Processing

Since gas reserves in Western Canada are predominantly sour, the operations required to condition a sour gas for sale will be described. Only the salient features of the most widely used gas plant operations will be dealt with as a detailed discussion of the processes involved is beyond the scope of this paper. To meet sales contract specifications gas must be processed to remove hydrogen sulphide (desulphurization), carbon dioxide, volatiles and water. A typical plant would consist of the following process units: treating plant, for desulphurization of the gas; absorption plants where volatiles are extracted; dehydration, where water vapour is removed; and a sulphur plant for recovery of elemental sulphur from the acid gases removed from the raw gas by the treating unit.

Fig. 3. Monoethanolamine gas treating plant flow diagram.



Desulphurization

The most frequently used method of desulphurizing gas on a large scale is to contact the gas with an aqueous solution of monoethanolamine. This process incidentally removes carbon dioxide as well as hydrogen sulphide and thus elminates both acidic constituents in one operation. This is a most important advantage should the gas contain an appreciable volume of carbon dioxide, as removal of this non-combustible gas upgrades the heating value. The process is continuous and regenerative making it possible profitably to exploit large sour reserves which otherwise would be of little value.

Purification or "sweetening" of the gas occurs in a bubble-cap tray column contacted at each tray by a countercurrent flow of monoethanolamine or "amine" solution. The representation of the column is simplified; in practice about 20 trays each equipped with several rows of bubble caps are used. The bubble caps force the gas to bubble through the solution flowing across the trays, effecting intimate contact with the solution at each tray. The hydrogen sulphide and carbon dioxide chemically react with the amine to form compounds which stay in solution and leave the bottom of the contactor in the rich solution. The reaction between the amine and acid gases liberates heat and thus the outlet temperature of the rich solution is higher than that of the entering lean solution.

A 20% by weight amine solution is usually used and the circulation rate is maintained at 2-3 mols of amine per mol of acid gas. For gas of the analysis shown in Fig. 3 the solution circulation rate would be about 25,000 Imperial gallons per million cubic feet of raw gas. When the solution to acid-gas ratio is 2:1 or higher virtually all of the hydrogen sulphide and carbon dioxide are removed.

The rich solution containing the acid gases in compound forms is regenerated by a continuous process and re-cycled to the contactor. Regeneration is accomplished by heating the solution which reverses the absorption reactions and releases the hydrogen sulphide and carbon dioxide. The operation is performed at low pressure in a still equipped with bubble-cap trays or ceramic packing. Before entering the still the solution is heated to 240°F. by exchange with the hot regenerated solution leaving the bottom of the column.

The hot rich solution is introduced about half-way up the column and as it descends is stripped of acid gases by a countercurrent flow of hot vapour. Evolved acid gases and water vapour leave the top of the still and are cooled to condense most of the water vapour. The condensed water is separated from the acid gas and refluxed to the top section of the still to knock down amine vapour and keep losses of this valuable chemical to a minimum. Acid gases from the reflux accumulator vessel are fed to a sulphur recovery plant. Stripping vapours are generated by boiling the lean solution from the bottom of the column in a kettle type reboiler equipped with a steam tube-bundle. The still is operated at low pressure to improve stripping and to permit boiling of the solution at a low temperature. A low boiling temperature is desirable to reduce corrosion and to avoid decomposition of the monoethanolamine which becomes unstable at temperatures much above 400°F. The hot lean solution is exchanged with the rich solution, then cooled to 90°F. and pumped back to the contactor.

Corrosion is the most serious problem connected with the operation of an amine gas treating plant. Attack is particularly severe in the reboiler; reboiler tube-bundles have failed after less than a year of service. Most operators have adopted the use of plain carbon steel as the most economical material for amine service. High-chrome alloys have given excellent service but the initial cost of these alloys is very high. Low-chrome alloys fail to give much longer service than carbon steel.

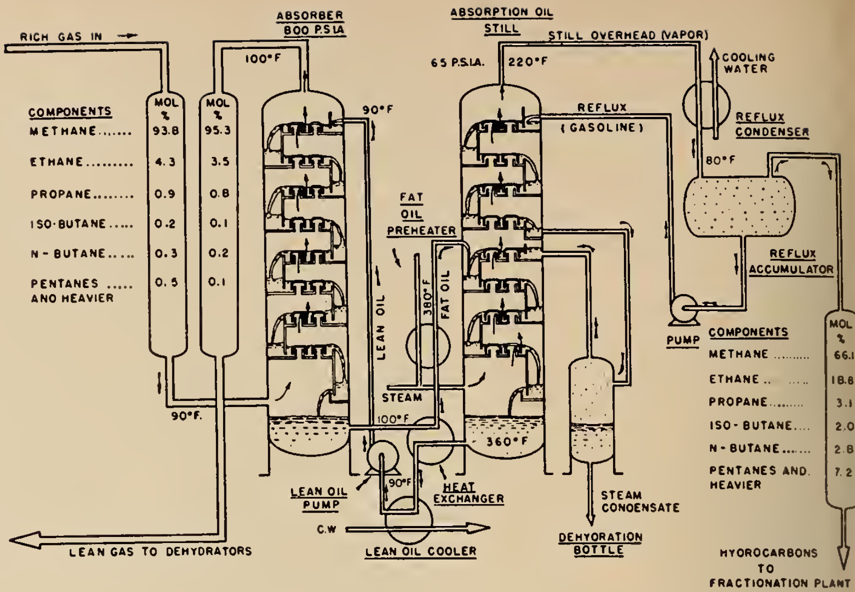


Fig. 4. Absorption plant flow diagram.

The next most serious problem encountered is the accumulation of corrosion products, iron sulphide, and amine degradation products in the system. When the concentration of these products is allowed to build up the solution exhibits severe foaming characteristics and it is necessary to reduce gas throughput to avoid upsetting the process and passing sour gas. Foaming also leads to high losses of solution in the sweet gas leaving the top of the contactor. The concentration of corrosion and amine degradation products in most plants is controlled by continuous filtration and distillation of slip-streams of the solution.

Volatiles Extraction

Condensable hydrocarbons, or volatiles, are removed from the gas to meet gas sales contract dewpoint specifications and to obtain revenue from the sale of propane, butane, and gasoline. There are two methods of extracting volatiles from the rich gas; absorption with light oil and refrigeration. Absorption is favoured for large operations and high recovery, whereas refrigeration is best suited for small installations.

Absorption

Figure 4 is a simplified flow diagram of an absorption plant. The rich sweet gas from the amine plant is passed through an absorption column to remove a portion of the heavy hydrocarbons. As the gas flows up the bubble-cap tray column it is contacted by a countercurrent flow of light oil similar to diesel fuel. By their affinity for the lean oil some of the volatiles are dissolved and leave the bottom of the absorber with the effluent rich oil stream. Absorption is a selective process yielding very high recovery of the heavier hydrocarbons present in the rich gas while only a small fraction of the lightest hydrocarbon, methane, is absorbed. The lean oil circulation required to extract a certain fraction of the volatiles from the rieh gas varies widely depending upon the richness of the gas and the operating pressure of the absorber For the particular gas and recovery of Fig. 4, the lean oil rate would be of the order of 3 gal. per 1000 cu. ft. of gas.

The absorbed hydrocarbons are removed from the rich oil by heating and then stripping the oil with steam at low pressure in a still, again a bubble-plate eolumn. The oil is heated to 380° F. by exchange with the hot lean oil from the bottom of the still and finally by means of high pressure steam in heat exchangers Then the hot lean oil is passed into the absorption oil still at mid-heigh where the volatiles are stripped ou of the oil by blowing steam up through the oil on the trays as it flow down the column. The hot hydrc carbon vapours stripped out of th rich oil leave the top of the stil are condensed and a portion refluxe to the top of the still to knock down vaporized absorption oil and thus reduce oil losses from the system. The rest of the volatiles are separated by fractional distillation into the liquid products desired; i.e. propane, butane, and gasoline. Stripping steam which condenses in the upper section of the still is decanted from the reflux stream in a dehydration bottle. The hot lean oil from the bottom of the still is cooled and re-cycled to the top of the absorber. Stripping is improved by operating the still at low pressure, in this case 60 psig.; however, the still pressure must be high enough to permit condensation of the overhead vapours with cooling water, otherwise refrigeration would be required. The absorption plant shown in Fig. 4 is a schematic representation only, as certain details have been omitted to simplify the description.

Refrigeration

Although less efficient than absorption, refrigeration is a simpler method for removing hydrocarbons from the rich gas. The rich gas is chilled to a temperature lower than the required dewpoint temperature and the condensed hydrocarbons separated from the gas. At the same time water is condensed, and thus there is no need for a further dehydration step as is the case when absorption is used to extract volatiles. Arrangement of a typical unit is shown by Fig. 5. Glycol is injected into the rich gas stream ahead of the refrigeration unit to prevent hydrates from forming which would otherwise result because of the presence of liquid water and the low temperature. The rich gas stream is cooled by exchange with the lean gas and finally cooled to 5°F. by passing through coils immersed in liquid refrigerant in the chiller. The condensed hydrocarbons, water and glycol inhibitor are separated from the gas and the lean residue heat-exchanged with the incoming gas. The water - glycol mixture is mechanically separated from the condensed hydrocarbons and distilled to concentrate the glycol for re-use. A conventional compression - expansion refrigeration cycle is used with ammonia or propane as the refrigerant.

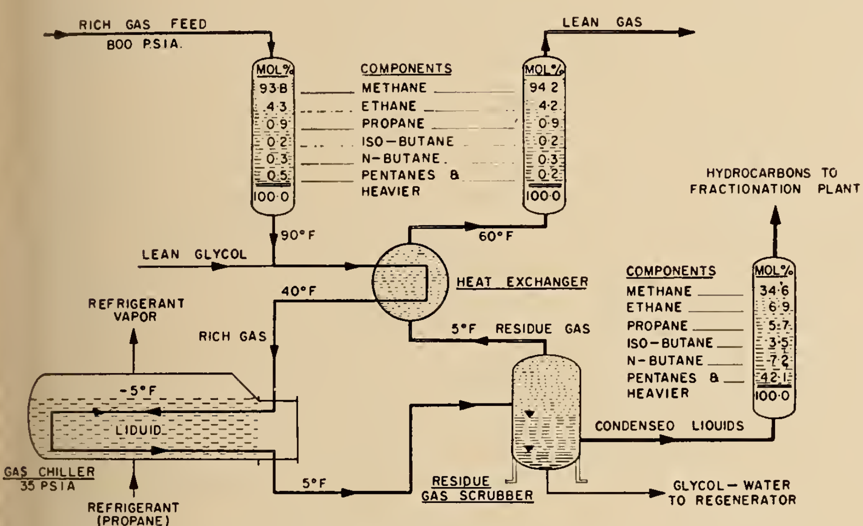
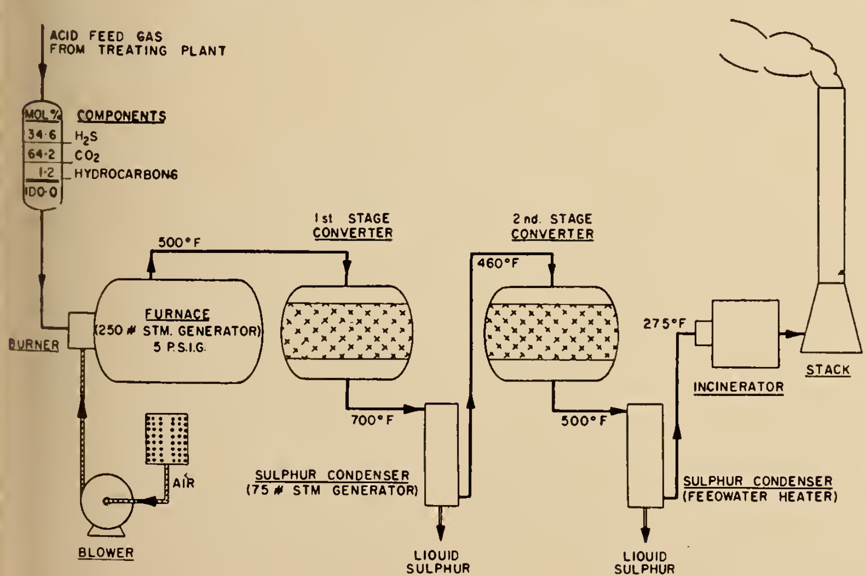


Fig. 5. Gas refrigeration plant flow diagram.

Fig. 6. Sulphur recovery plant flow diagram.



Dehydration

After sweetening the gas by amine treating and removing hydrocarbons by absorption the gas is dehydrated. The water content of the gas is reduced by passing the gas through a vessel containing a bed of granular silica gel which removes the water vapour by adsorption. The gas at this point meets all contract quality specifications and is ready for sale.

Sulphur Recovery

Sulphur is recovered from the acid gas effluent from the amine solution regeneration stills. Besides the obvious profit motive, sulphur is recovered to avoid serious atmospheric pollution which results when large volumes of hydrogen sulphide are flared. The sulphur recovery process is illustrated by Fig. 6.

One third of the hydrogen sulphide in the acid gas feed is burned with air to form sulphur dioxide which is then reacted with the remaining two-thirds of the hydrogen sulphide to form elemental sulphur.

$$H_2S + \tfrac{3}{2}O_2 \rightleftharpoons SO_2 + H_2O$$

$$2H_2S + SO_2 \rightleftharpoons 3S + H_2O$$

The first reaction takes place in a furnace in which temperatures of the order of 2000°F. are attained. The gas is cooled to about 500°F. by generating steam and then passed through a bed of bauxite catalyst to promote the conversion reaction. Conversion takes place throughout the plant but most of the conversion takes place in the first catalytic converter. The temperature of the gases leaving the converter is higher than the inlet temperature because heat

(continued on page 1272)

Transporting and Marketing Natural Gas

B. F. Willson, M.E.I.C.

Vice-President Operations,
Canadian Western Natural Gas Co. Limited, Calgary, Alta.

Read at the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June, 1957.

CANADA'S ENERGY requirements are expected to triple in the next 25 years. The Gordon Commission estimates that natural gas—now supplying 4 per cent of our energy requirements—will be providing 25 per cent of the much larger requirements of 1980. What other industry can look forward to such a phenomenal rate of growth? What other industry offers such a challenge to the engineering profession? Clearly the natural gas industry in Canada is today in its infancy and the engineering profession's role in the development of one of our most important natural resources will be a most significant one.

In this paper, I propose to follow the gas supply from the inlet of the transmission system, through the distribution systems, to the point of delivery at the consumers' premises. The paper will deal firstly with a brief consideration of the economic feasibility studies necessary in considering a pipe line project, secondly, with the engineering aspects of the project, and thirdly, with some of the economic and cost features.

The construction of any natural gas pipe line involves the expenditure of substantial sums of money. The transmission system of Trans-Canada Pipe Lines over its 2,200-mile length, is estimated to cost $350 million. It is apparent, therefore, that detailed economic studies justifying the construction of each project must be undertaken before the project can become a reality. Time does not permit going into great detail on the various aspects of these economic studies but certain of them should be mentioned.

(1) Careful estimates of the existing market potential must be prepared. This involves a study of weather conditions as well as a survey of the potential sales of gas to residential, commercial and industrial customers.

(2) Forecasts of market growth are required to provide data on which to base the engineering design of the pipe line system. Such forecasts also provide the basic data for projected earnings statements.

(3) All aspects of competitive fuel costs must be investigated. Estimates of market demand are only realistic if natural gas can be sold at rates competitive with other fuels.

The production of natural gas as far as the stage when it is ready for further distribution to the consumers has been described in the paper by Mr. Dillon (p. 1265). To continue the story, the present author deals with the supply of gas through the transmission systems to the point of delivery.

(4) An assured long-term supply is essential for the financing of any major project. This entails detailed studies of available gas reserves, their deliverability, the negotiation of gas purchase contracts with the producers and the finalization of such matters as the load factor and price of each individual supply.

(5) A preliminary engineering study and design of the transmission system must be made. Calculations of total annual fixed and operating costs are necessary for the economic appraisal of the project.

(6) Similar engineering studies and designs of the distribution systems in the market areas are required.

(7) Financial projections of estimated costs and revenues can then be compiled. If these projections show a favourable picture, it is then possible to interest financial houses in the underwriting of the total project.

Let us assume for the moment, that we are interested in promoting a major natural gas pipe line which will be built to connect suitable sources of gas supply with market areas previously not served with natural gas. Let us also assume that the economic feasibility studies mentioned above have been carried out in detail and that a favourable picture is indicated. What then are some of the engineering considerations for the project itself?

First let us look at the transmission line. Again time does not permit going into detail on the various engineering aspects of the transmission system. I will mention the more important ones.

The design of a major pipe line has the objective of transporting the gas supply itself from the fields in which it is located to the markets at the lowest possible unit cost consistent with sound engineering practice. Factors to be considered in the design might be listed as follows:

(1) Location of the Various Sources of Supply

Any major pipe line will undoubtedly require to be supplied from more than one source. Therefore the system gathering the gas from the various individual fields must be engineered and planned having in mind the same factors and objectives as the transmission line itself. That is to say, many designs must be tried and costed in order to be sure that the one selected is the most economical. Topographical features must be considered in selecting pipe line routes. The geology of the area to be traversed by the gathering system is important in that the decision as to fina location should be made not only on the basis of the location of present gas reserves but also on the basis of the probable location of future discoveries.

(2) Quantities to be Handled

A proper and desirable design is one which yields low ultimate transportation costs and at the same time, reasonable initial costs during the early years of the project when the markets are being developed. Therefore the design must be studied and unit costs determined at various rates of flow in order to assure that the design is an optimum one from a cost standpoint.

(3) The Load Factor of the Operation

While it might be assumed that the load factor of the main transmission system will be the same as the load factor of the markets, this does not necessarily hold true. The role of storage is of major importance in a gas transmission project and storage can take many forms. Line pack (storage in the pipeline itself) frequently enables maximum hourly demands to be met from a pipeline designed for throughput equal to only the average hourly demand of the peak day. Above-ground gas holders achieve the same result as line storage but have the disadvantage of being costly. Underground storage in depleted gas reservoirs usually presents the most economical storage for a major pipe line project. The existence of such reservoirs enables the transmission line to operate at high annual load factors with maximum winter demands being met by a combination of supply from both the pipe line itself and the storage fields. During the summer months, gas surplus to market requirements is stored in the underground reservoirs to be available for the succeeding winter months.

(4) Quality of Pipe Available

Due to the tremendous tonnages of steel required by a major pipeline project, the allowable operating stress in the steel itself is a matter of considerable importance. Formerly pipelines were built using steels having minimum yield strengths of 30,000 to 35,000 pounds per square inch. An allowable operating stress of 72 per cent of the minimum yield strength was considered good practice. However, in the postwar years, notable advances have been made by the steel and pipe fabricating industries with the result that there is now available line pipe having minimum yield strengths of 46,000 and 52,000 lb. per sq. in. The recently prepared code of the American Standards Association (ASA B 31.1.8-1955) for Gas Transmission and Distribution Piping Systems permits operating stresses up to 72 per cent of specified minimum yield strength for what is defined as Location Class I (cross-country pipeline systems in relatively open country) even though these high strength steels have certain brittle tendencies. Therefore the availability of high strength steels has an important bearing on the wall thickness necessary to withstand any particular operating pressure.

(5) Pipeline Design Formulae

Major American operating pipeline companies have developed empirical formulae as a result of observing large diameter pipelines in operation. These formulae give more realistic results than earlier ones developed by pioneers of the gas industry. One of the more acceptable formulae is that developed by Panhandle Eastern Pipe Line Company. It takes into account such factors as the inlet and outlet pressures of the pipeline, the inside diameter and length of the pipeline, the specific gravity of the gas and, of course, the quantity itself. It employs an efficiency or experience factor which is used to adjust for slightly different characteristics of each individual pipeline.

(6) The Spacing of Compressor Stations

Major engineering studies are necessary in order to determine the optimum spacing for compressor stations. These studies relate to the economics of providing for daily pipeline capacity by the installation of either compressor horsepower for increasing the pressure differential between compressor stations as compared with the provision of additional pipeline capacity through a larger diameter line or a looping pipeline. This latter alternative has the effect of reducing the resistance to flow in the line itself and hence, increasing its capacity. Experience has shown compressor station spacing of 100 to 150 miles to be the most economic but each installation must be engineered on the basis of the circumstances which prevail.

(7) Operating Pressures

Closely linked to the matter of compressor station spacing is the question of operating pressures for the pipeline. This again is a question of engineering economics and is influenced by such matters as the pressure at which the gas supply is available, the distance to the markets, the quality and type of pipe available and the anticipated growth in the markets to be served.

These are what might be considered the major engineering considertions in the design of a gas transmission line. You will note that while a number of these factors are capable of precise mathematical solution, others are judgment factors. Therefore the final design of any pipeline to a greater or lesser extent must be dependent on the experience and background of the executive engineer in charge of the design.

The design of gas distribution systems within the market areas must be based on consideration of essentially the same factors as were studied in the transmission pipeline. A block by block survey of residential, commercial and industrial areas is the framework on which the design is anchored.

From the market survey emerges the estimated peak hourly demand for each section of the particular area being studied. These hourly demand quantities plus a judgment location for the major distributing pipelines form the basis of what is called the intermediate pressure system. The actual size of each distributing main is determined by application of a pipeline flow formula.

The pressure drop in each section of gas main is calculated by taking into account the quantity to be handled, the length and diameter of the section and the pressure of the gas available at the inlet. Adjustments in the design are made by varying the diameter or pressure conditions in the pipeline. Maximum operating pressures are governed by the A.S.A. Code mentioned previously, gas industry standards and safety considerations generally.

The distribution design finally adopted is the result of numerous calculations and a trial and error procedure. Again judgment must be used to determine the allowance to be made for future growth in the area to be served as well as extensions to that area. Experience and a knowledge of gas industry problems are essential background for the gas distribution engineer.

Other Engineering Considerations

Mention might be made of other engineering considerations which must be faced and designed by the engineer.

Gas quantities must be measured at the wellhead, at the inlet to the transmission system, at the start of the distribution system and at the point of delivery to the consumer. Problems encountered in measurement are numerous and complex with the result that the position of measurement engineer in any gas operation is an important one.

Control of gas pressures at all points on the system is another matter which merits close attention by the operating personnel. The design of pressure control installations and their efficient operation is an engineering matter of significance in the total scheme.

Because of the inherent danger which exists if natural gas is not handled properly at any stage of its travels from the reservoir to the burner tip, it is necessary to add a distinctive odour so that any raw or unburned gas is readily detected. Odorization of the gas supplies, therefore, is another matter which must be carefully engineered and controlled.

It was stated at the start of this paper that mention would be made of some of the economic and cost features of a pipeline project. Throughout the paper you have probably realized that a natural gas pipeline is not unlike numerous other engineering undertakings in that economic considerations govern, to a considerable extent, the design of the various elements that make up the total project. Therefore we will not dwell further on the economic considerations other than to point out the obvious fact that the pipeline project must make money in order to succeed.

With respect to the cost aspects, some unit cost data might be of interest.

In 1950 our Alberta gas utility companies could build transmission lines for $1800 per inch diameter mile. That is to say, a 16-inch pipeline cost about $29,000 per mile. By 1956 the cost had risen to $2,700 per inch diameter mile and present pipe quotations indicate that the installed cost of a 16-in. pipeline next year will be $54,000 per mile or nearly $3,400 per inch diameter mile. Sharp increases in the price of the pipe itself, together with substantial increases in labour rates, have brought about this near-doubling of 1950 costs.

Unit costs applicable to distribution systems have also increased somewhat alarmingly in recent years. The average capital cost per customer in thirteen communities served with natural gas for the first time in 1956 by Canadian Western Natural Gas Co. was $261. The minimum per customer cost was $217 and the maximum $471. Obviously, the spacing of dwellings and the intensity of the development generally are the largest factors affecting distribution costs. In connection with the per customer capital costs in larger eastern centres of population, one would expect them to be somewhat higher than those of smaller communities in Alberta.

Once an integrated transmission and distribution system has been designed, the engineer must play his part in the construction, operating and maintenance phases. Undoubtedly the engineer will move ahead to the executive positions because his knowledge of the background and details of the entire operation make him ideally suited as a policy and decision maker. The opportunities for the engineer in the natural gas industry appear almost limitless and it is to be hoped that Canadian engineers will take their rightful place alongside our American friends who pioneered in an industry that is, today, the sixth largest on the North American Continent.

Transportation of Oil

(continued from page 1264)

I have not touched at all on the problems of operation, mechanical maintenance, right-of-way maintenance, communications or corrosion— any one of which could well be the subject of numerous papers of this length. However it will be obvious to you, and your Institute, that engineers play a major role in many of the phases of pipelining and there is a place in the industry for people from almost every branch of your profession. They will find it most fascinating and professionally rewarding. They may develop ulcers, or die of heart attacks, but I can assure you, they will never die of boredom.

Canada has virtually reached the point of self-sufficiency as far as petroleum refining capacity is concerned. Exploration and production are rapidly approaching this condition and in spite of the steeply rising consumption of petroleum products which is accompanying the increase in population and industrialization, we could quite conceivably be in a net export position within a very few years. The transportation industry is ready to play its part in this growth.

Gathering and Processing Natural Gas

(continued from page 1269)

is liberated by the conversion reaction. Sulphur formed as vapour in the first converter is condensed by cooling the converter exit gas in a heat exchanger by generating low pressure steam. The gas stream is passed through a second converter, cooled, and entrained sulphur removed in a mist eliminator or coalescer. The residual sulphurous gases are burned in an incinerator to avoid atmospheric pollution. The sulphur condensed in the various plant units is continuously drained to a concrete pit from which it is periodically pumped to solid storage blocks or directly to liquid tank cars.

It is common for sulphur plants employing two stages of conversion to recover 85-90% of the sulphur in the acid gas feed. Purity of the sulphur is exceptional; usually higher than 99.5%.

Processing Costs

Costs involved in processing sweet gas, rich in volatiles, are more than offset by the income from by-products. However, in the case of sour reserves, requiring amine treatment to remove hydrogen sulphide, processing is costly and expenses usually are only partly defrayed by the value of by-products recovered.

Petroleum Refining

C. W. Coote, M.E.I.C.

Manager, Edmonton Refinery,
British American Oil Company Limited, Edmonton, Alta.

Read at the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June, 1957.

The refining of petroleum has developed technically to a great extent in recent years. The paper deals with design, operation, and some of the products.

FROM THE combined results of previous speakers in this series, we may find the refinery crude oil storage tanks being filled with anything from a straw-coloured distillate, much lighter than water, down to a black molasses-like material of about the same gravity as the cooling water. Our job is to get the right combination of people to design, build, operate, and maintain the refinery, so that the end results will find a ready market at a profitable price. Engineers by themselves do not make too good an all round working team, so accountants, chemists, graduates of the school of hard knocks, and administrators are needed throughout all phases. All types of engineering graduates are employed, with the greatest emphasis on mechanical and chemical. The plant will normally be automated to a very high degree, so that the requirement for human labour in operations is often reduced to the point where the number of men on a shift is only that required for fire-fighting and general plant protection. This does not mean to imply that the people there on a shift basis have nothing to do. They are normally highly skilled operating personnel, who have put in many long hard years learning the business. They must know what to do, where to go, and to act quickly in case of failure of automatic controls, or of any part of the processing equipment, since the raw, intermediate, and finished material has a great deal of latent energy in it, and if this material is not properly controlled, the fire and explosive hazard is tremendously high. The heat energy in a pound of gasoline is three times that of T.N.T. and six times that of nitroglycerine.

A rough round figure of plant investment cost is $1,000 per bbl. of daily crude throughput for a medium sized plant (25,000 bbl. per stream day). This figure can easily be doubled for a small, but complete plant, and will naturally be somewhat less for units of larger size.

Location

Wherever possible, a minimum of one-half section of land is required for a 25,000 bbl. per day plant. It will be usually located near the market for its products, although in a few cases it may be near the source of the crude oil, and the markets may be at some distance. It is generally more economical to locate the plant near the market, and bring the crude oil to the plant by whatever means available. Since the basic refining process is one of elevated heat, with temperatures in the 200 deg. F. to 1100 deg. F. range, accompanied by varying degrees of elevated pressure, a large supply of cooling water is absolutely essential. Other utilities such as cheap and abundant electricity, make-up supplies of fuel, and water for domestic purposes are required. Consideration of the problem of pollution of water, air, and surrounding countryside must also be made. If definite plans are established to combat and control pollution before the plant is erected, a great deal of money can be saved in the long run with much better public relations for the plant right from the start.

Design

Refining is a fascinating business, in spite of the fact that it is an industry where a layman or an engineer, not normally associated with the industry, going through a refinery finds it quite difficult to visualize what is going on. This is due to the fact that the raw material comes into the plant, is processed, and the products are loaded or transported out of it, with little or no chance to see the raw material, intermediate products, or the finished ones, except on laboratory samples. Recently, a very large oil company, in opening some new buildings in their research centre, stated "Today you can run your car, lick your hair, dress in the latest fashion, mow your lawn, oil your watch, kill moths, grow flowers, heat your home, air condition your office, shine your shoes, all with tools powered by, or lubricated with oil or oil products made from petroleum. At last count there were more than 4,000 products made from petroleum, a list which increases daily." It is not my purpose to begin to tell you how or where more than a small fraction of the 4,000 products are made, but to take you on a tour of a modern integrated refinery, and to spend a moment here and there telling you where a more complete refinery would draw its raw material from to go into many more of the by-products or of the specialty products which can result from the original processing of crude oil.

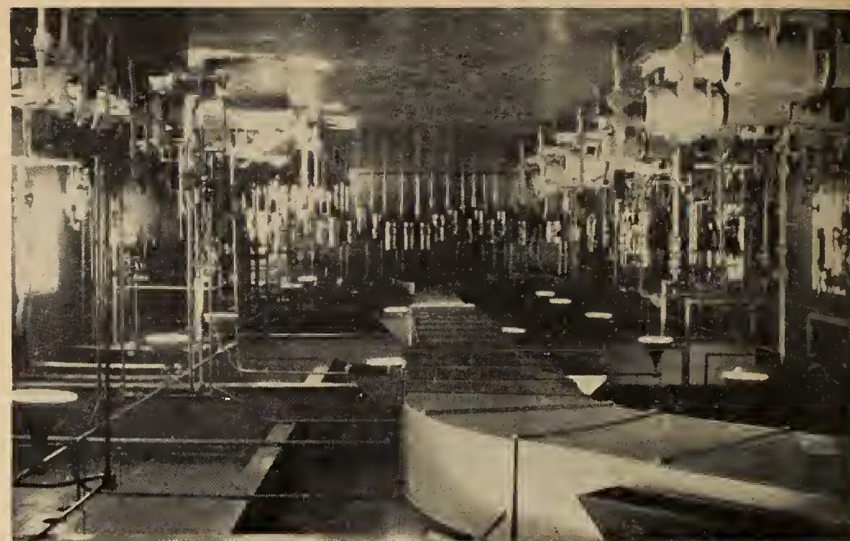
The design work is usually done by a staff of specialists, either in the employ of the oil company itself, or in that of a contracting company, which specializes in oil refinery design. Greater attention is being paid now to efficiency and operating costs than ever before, since the cost of labour and materials is continually increasing, whereas the price of the products of a refinery on a tax free basis have not risen in nearly the proportion that labour and material have.

Operation

Let us look at the flow through a refinery where the processing is relatively simple, and at the same time modern. This will provide us with some talking points to illustrate the operation of a modern refinery.

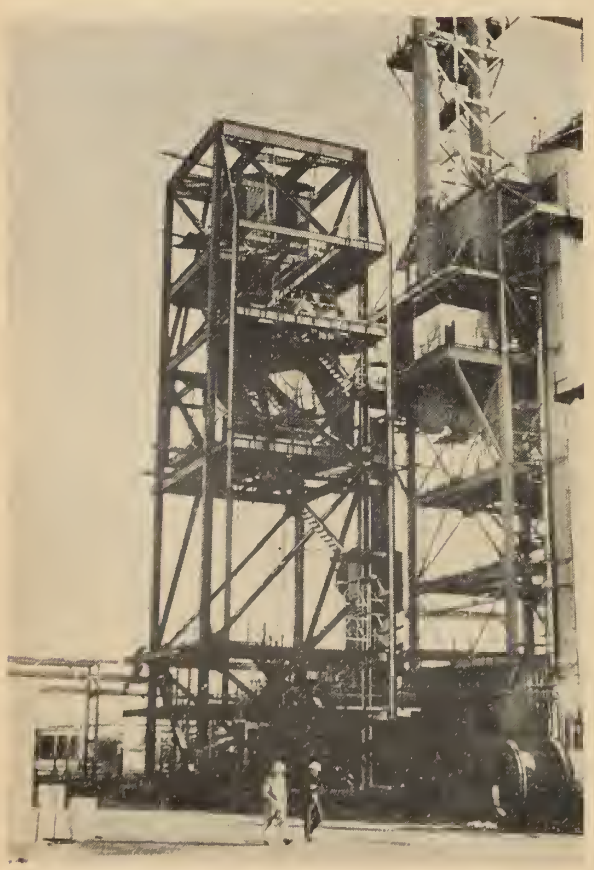
Raw crude is a mixture of a large number of hydrocarbons, and the basic chemical nature of the oil will determine the physical and chemical properties of most of the end products. In addition to a large number of hydrocarbons of varying chemical structure, the crude will contain some unwanted material, including sulphur in varying forms and amounts, and foreign bodies produced with the oil, mainly soluble salts, such as chlorides and sulphates, which present a big problem to the refiner. If they are not removed, they will foul up the heat exchanger trains, which are very important when high temperatures are involved.

In order to give a homogeneous type of oil to the refinery, most crude oil storage tanks are equipped with either suction heaters to keep the oil flowing at all temperatures, and/or propellor type mixers. The problems of delivering oil by pipeline to a refinery, and accounting for it on a metered basis, have many ramifications and are not common, with the result that most refineries have a minimum of two large crude oil storage tanks. The number may vary from this up to a dozen, depending upon such factors as the type of processing of the plant, the frequency of delivery of crude, and the number of different types of crude oil processed which it is desired to segregate. These tanks, along with the intermediate and finished product storage tanks, may be equipped with automatic gauging and temperature measuring equipment, whereby the amount of crude oil and its temperature in the tank, may be measured without climbing to the top, or may be measured even at a remote point.



Treating plant pumphouse.

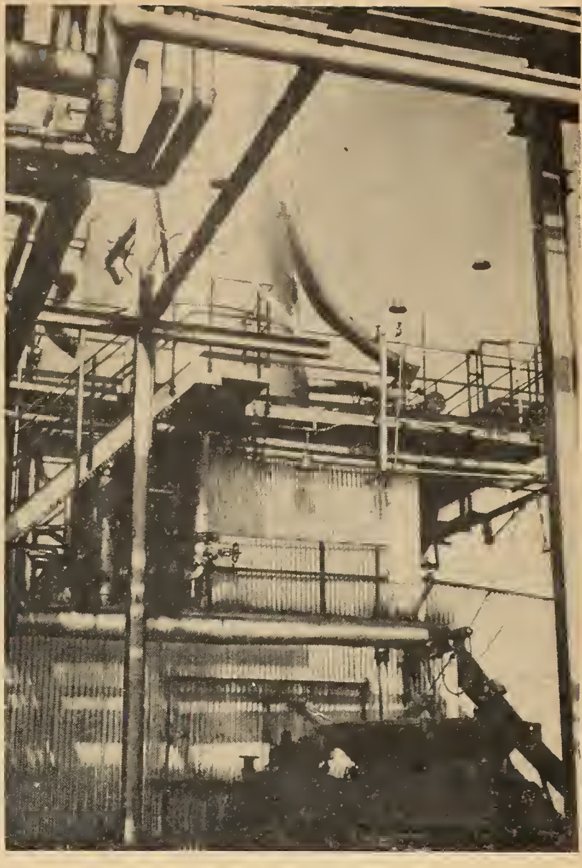
The first stage of processing is to get rid of the undesirable salts in the crude. This is accomplished by heating the oil, usually by heat exchange, with a hot stream leaving the processing area, and adding water to the crude. The salt goes into solution and the brine is separated from the oil either by residence time in a large vessel, aided by chemical de-emulsifiers, or by electrostatic precipitation, using high-voltage low-amperage fields. The refiner aims to get the salt content down to one pound of salt per thousand barrels of crude or less before further processing. The crude oil is now pumped through a tube still heater, where its temperature is raised to about 700 deg. F., and then flashed into the bottom of a distillation tower. In the fractionating tower, the light components of the crude oil, which have been vaporized, will tend to rise through the bubble-deck trays, on each of which is maintained a level of liquid reflux. The dense heavy components tend to go to the bottom of the tower, and will be drawn off for further processing. The topped or reduced crude, as it is known, from the bottom of the basic fractionating tower may proceed to a vacuum tower, where additional distillation is conducted under less than atmospheric pressure for the



Coke drum and drill equipment.

production of lubricating oil base stocks and asphalt or it may go to a coking unit. If neither of these are available, the reduced crude will be blended for heavy bunker fuel. From the main distillation tower, we will get light gasoline overhead, along with heavy gasoline, solvents, kerosene, diesel fuel, and gas oil for further processing as side draw products. These will require steam stripping, treating, and blending before they can be turned into finished products. The most common forms of product treating involve the use of caustic soda or sulphuric acid. Either of these chemicals in varying strengths and combinations, will either remove or convert the undesirable chemicals in the raw products, so that when burned in an internal combustion engine, or in a lamp, they will not exhibit harmful properties. Bauxite is commonly used; the effect being to convert some forms of sulphur into hydrogen sulphide, which can be separated from the product by distillation.

Carbon monoxide boiler.



In our plant, we will take the reduced crude through another pipe-still heater, where the temperature and pressure are raised to high levels, and the resultant synthetic cracked mixture flashed into an open drum. In this drum, at reduced pressure, the mixture will deposit solid coke, and the vapours produced in the cracking reaction will go overhead from the drum into a fractionating tower, where cracked gasoline and gas oils will be recovered. The coke builds up as a semi-solid layer from the bottom towards the top of the drum, and when it is approximately two-thirds full, the flow is switched to another drum. After this is done, steam is introduced to the coke bed to remove the oil and vapour, following which it is cooled using large amounts of water. At the end of the cycle, the drum is unheaded and drilled out, using a combination of hydraulic-mechanical drilling. The product, petroleum coke, is sold largely to the aluminum industry and used in the electrolytic reduction of alumina. In recent years, a fluidized coking process has been developed, which produces coke continuously in a fine particle state, but the use of the latter product is more restricted. You will appreciate that the operating variables in a coking process must be very closely controlled, otherwise the coke will be deposited at the wrong place in the unit, fouling up the equipment and forcing a shutdown for cleaning out.

Laboratory knock engine.

With regard to the alternative method of residual handling, asphalt production, I would like to request that any of you here who are users of road or industrial asphalts will support and continue the efforts which have been started to reduce the multiplicity of grades of road paving asphalts as well as industrials to a more sensible figure.

In an effort to produce more and more gasoline of higher and higher quality, the fluid catalytic cracking process was developed in the early years of World War II, and has become the backbone of today's refinery. In the fluid process, of which there are many versions, the heavy gas oil produced from the atmospheric crude distillation tower is cracked at moderate temperature and at low pressure in the presence of a catalyst. The catalyst is a very fine powdery material, which may be a naturally-occurring clay, or a synthetic product from a chemical manufacturing plant. Most of the fluid processes circulate large volumes of this finely powdered material, which although a solid in its normal state behaves as a fluid when fluffed with air and oil vapours. Fluid catalytic crackers have a wide range of operating conditions and these will be varied to produce the desired end products, as well as to consume all of the gas oils which are available for cracking. The end result is a maximum production of total white products; i.e., gasoline and heating oils, with a minimum production of coke and gas. In the cracking reaction, coke is deposited in a very fine form on the catalyst, which goes from the reactor to the regenerator, where the coke is burned off the catalyst, using large volumes of air. In the regeneration step, flue gas is produced at a temperature of approximately 1100 deg. F. and may contain up to 8 per cent of carbon monoxide.

In areas where outside sources of fuel command a high price, this gives the refiner an ideal position to demonstrate efficiency by the installation of a CO boiler. This is basically a conventional water tube boiler, but the combustion space is very large. The fuel consists of flue gas from the catalyst regenerator, containing CO which will be burned to CO_2, thus liberating substantial quantities of heat. Auxiliary fuel consisting of gas, fuel oil or even coal, will be used to generate large volumes of steam. In the construction and operation of a CO boiler, it is necessary that the duct work conducting the flue gas from the catalytic cracker to the boiler be arranged so that the cracker will not have to shut down if it is necessary to shut down the steam generator.

The octane race is continually going on, with the prediction being voiced recently that the premium gasoline in the United States will average 107 octane, and house brand gasoline 98 octane in 1965. The average compression ratio will be 12 to 1 by 1961, and the average of all leaded motor gasoline sold will go up to 101. This will cost the refiner an estimated 60c per bbl. more to manufacture the products. There is a limit to the octane improvement effected by the addition of tetraethyl lead, and by law no motor gasoline may contain more than 3.6 c.c. per Imperial gallon for safety reasons.

One of the more modern methods used to produce more high quality motor gasoline is catalytic reforming. There are several patented processes, some of which are regenerative, others non-regenerative, all of which use low-grade straight-run gasoline as a charge material. In upgrading the octane quality of the gasoline, once again, more light ends are produced, which must be either burned as fuel or processed to become a stable liquid, which can go into the motor gasoline pool.

All of the gas produced is usually concentrated and recovered in a common section of the plant. There is very little use in the refinery itself for the methane and ethane, but sometimes these find a ready market in a petrochemical industry, which may be located in the area. The unsaturated C_3 portion of propylene may be used as a raw material in the production of cumene, in a Friedel-Crafts reaction with chemically pure benzol. Propylene and butylene in combination with iso-butane, may be used to form motor or aviation alkylate using concentrated sulphuric or hydrofluoric acid as a catalyst. Since there is an overall shortage of iso-paraffins for alkylation feed, and upgrading of motor gasoline, some refineries are built to convert normal paraffin hydrocarbons into iso-compounds. Aluminum chlorides suspended on bauxite can be used as a catalyst for this process.

The following table gives an indication of yields from the processing.

All gasoline and solvents	50 to 60%
Kerosene, diesel, lub. oil	20 to 30%
Bunker, coke, asphalt	10 to 20%
Fuel and loss	5 to 15%

In addition to simplified equipment which is used running routine control tests on such characteristics as colour, distillation, flash, fire, viscosity, gravity, pour point, melt, and penetration, more elaborate equipment is used to analyse particular fractions of the refinery products, and to determine the quantities of sulphur and the forms that sulphur is present in. Some of this equipment is extremely expensive; for example, a mass spectrometer, one of the newest analytical tools, used for light hydrocarbon research, costs approximately $60,000 installed in Canada. This instrument includes a two-ton electromagnet, operates at high vacuum (one ten-millionth of a millimetre of mercury) and is based on the principle that positively charged molecular particles or ions have a different weight or mass. The mass spectrum for any pure compound is characteristic of its molecular structure, and is reproducible. This exact reproducibility provides the means for precise analysis, both qualitative and quantitative.

One essential laboratory tool is a knock engine. This is used to determine the octane quality of the gasoline products of the refinery, by comparing the fuel with other gasolines of known octane number. With the production of motor gasoline approaching 100 octane rating, and even exceeding it in some cases, considerable thought and study has been given in the last few years, and is still going on, to a satisfactory way of universally rating gasolines over 100 octane rating. Aviation gasolines for internal combustion engines are rated on performance, rather than on straight octane number, e.g. 115-145 aviation gasoline, indicates the performance numbers at takeoff and at cruising speed, in relation to the performance of straight iso-octane under similar conditions.

Mention of aviation gasoline may cause you to wonder about jet fuel, its production, and the different forms. There are two main types of jet produced today; one known as the gasoline type, which is essentially a straight run gasoline with a low vapour pressure (below three pounds, measured at 100 deg. F.). This type is used in most of the military jets. The other common type is known as the kerosene type, which is essentially a product very similar in distillation range to coal oil, the original coal of the refiner 50 years ago. This type seems to find more favour with the jet engines used on commercial aircraft.

Auxiliary Facilities

The refining process is one which must go on continuously, operating around the clock, and throughout most of the year. Refineries today will average 92 per cent on stream time efficiency for the most difficult units, and up to 95 per cent time efficiency for those processing units where coking is not a problem. Large quantities of high purity steam are required for essential drives, as well as for processing and for fire protection within the refinery. A permanent fire-fighting system is usually installed within the entire plant area, and augmented by portable fire equipment which can be moved right

(continued on page 1287)

The Petrochemical Industry

J. H. Shipley

Vice-President,
Canadian Industries Limited, Montreal, Que.

Read at the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June, 1957.

THE SUCCESS of the oil industry, and the large scale of its operations resulting from that success, have made many potential raw materials available at prices which are often lower than those for alternative raw materials from other sources. The chemical industry has been quick to realize the advantages that petroleum-based raw materials could give it. On the other hand, the oil and gas industry has rapidly adopted the techniques of the chemical industry to diversify and upgrade its products. As a result the new petrochemical industry has arisen. It is this industry, and the factors influencing its growth in Canada, which I propose to review with you today.

It may be well to start out by defining what we mean by petrochemicals. Petrochemicals are chemical products derived from petroleum, the term petroleum being used in its broadest sense to include crude oil, natural gas and their by-products. Figure 1 gives the names of some representative petrochemicals, and you will note that only a few of these will be familiar to those without some chemical training. Most petrochemicals undergo further processing or compounding before they reach the consumer, so that the petrochemical origins of many finished products go unrecognized. For example, most of the newer synthetic fibres such as nylon and "Terylene"; the plastics polythene, p.v.c. and polystyrene; and synthetic rubbers are largely dependent upon petrochemicals as intermediates.

Factors Influencing the Industry

The growth of the petrochemical industry in Canada has involved one choice after another. Earlier speakers have pointed out the variety of potential raw materials produced by the oil refining and natural gas industries. Another fact which may be less well known is that the same petrochemical can often be made in more than one way and from more than one raw material. For instance, as shown in Figure 2, polyvinyl chloride resins are currently being manufactured competitively by several different routes from natural gas and crude oil, as well as from coal, which is not a petrochemical source. One of the first choices is, therefore, that of which raw material and which manufacturing process to use.

Although still relatively small, in terms of volume of products, the Canadian petrochemical industry is one of the leaders in rate of growth and economic importance. Some of the products and their markets are discussed in this paper.

Since technical research often produces different products which compete with one another, a new product must be able to withstand not only direct competition from other manufacturers of the identical product but also indirect competition from other products which can serve essentially the same purpose.

The markets for petrochemicals differ considerably in size across Canada and are often concentrated at some distance from the source of the cheapest raw materials. Therefore, either the raw materials or the finished products must be transported.

Furthermore, manufacture cannot be undertaken economically unless a sufficiently large market is available and the effects of tariffs, both in our own country and in others, on the size of the available market are extremely important.

Very briefly, then, raw materials, manufacturing processes, size and location of markets, freight and tariffs are the factors which have controlled the location of petrochemical plants and the development of the petrochemical industry in Canada and will continue to do so in the future.

I would now like to amplify and illustrate these remarks.

Raw Materials for Chemical Industry

The oil and gas industry provides four main sources of raw materials for the chemical industry. Figure 3 shows these diagrammatically. They are:

(1) Crude oil

(2) By-products of refining crude oil, in particular refinery off-gases from cracking operations which contain ethane, ethylene, propane, propylene, butanes, butylenes, etc.

(3) Natural gas, which is usually composed largely of methane.

(4) By-products of natural gas, such as ethane, propane butanes and sulphur.

These raw materials for the petrochemical industry are available at various places across Canada, as shown in Figure 4.

Natural gas and its by-products occur most abundantly in the West and refinery by-products mainly in the East, while crude oil is available at most locations in Canada from domestic sources or from imports. With the growth of the oil and gas industry and the construction of long pipeline systems, the availability of petrochemical raw materials is being steadily increased and widened.

Most petrochemicals are compounds which contain the element carbon. It is helpful, therefore, to compare the costs of the various oil

REPRESENTATIVE PETROCHEMICALS

HYDROCARBONS	OXYGENATED CHEMICALS
ACETYLENE	ACETONE
BUTADIENE	ETHYLENE GLYCOL
DODECYLBENZENE	FORMALDEHYDE
ETHYLENE	METHANOL
PARA-XYLENE	PHENOL

CHLORINATED CHEMICALS	INORGANICS
ALLYL CHLORIDE	AMMONIA
ETHYL CHLORIDE	CARBON DIOXIDE
ETHYLENE DICHLORIDE	HELIUM
PERCHLOROETHYLENE	SULPHUR
VINYL CHLORIDE	

Figure 1.

and gas raw materials in different parts of the country on the basis of their carbon content. This is shown in Figure 5.

Natural gas in Alberta or the Peace River district is the cheapest petrochemical source of carbon in Canada at just under one third of a cent per pound. Transportation increases this cost rapidly east or west, so that the cost of the same pound of natural gas carbon in Toronto is just over four times the cost in Alberta. In the Prairies, crude oil and natural gas liquids are more expensive sources of carbon than natural gas, but in the East the costs of carbon in the form of crude oil, refinery gases or natural gas are quite close.

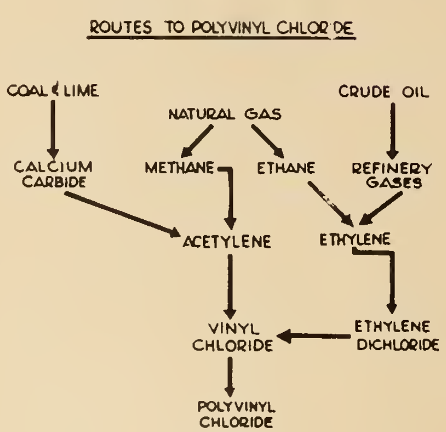


Figure 2.

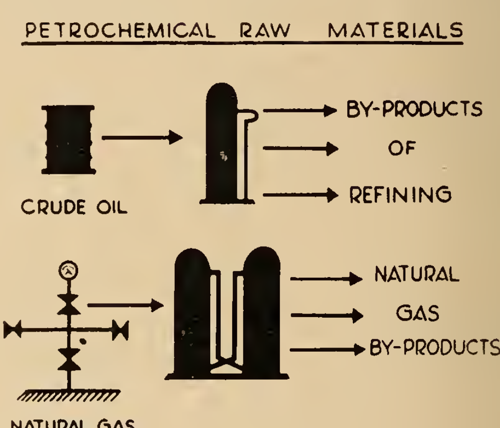


Figure 3.

These facts pose one of the main problems in the manufacture of petrochemicals. Should one take advantage of the cheaper raw materials in the west and ship the product to the major markets in the East, or should one use the dearer raw materials in the East with the consequent lower delivery charges on the finished products? The answers to this question have to a large degree controlled the pattern of development of the industry in Canada.

Technical

Before discussing the development of the petrochemical industry in Canada, I believe it would be desirable to say a few words on the two main routes followed in going from the raw material sources to the final products.

Generally, the first step is the production and isolation from crude oil or natural gas of relatively pure individual hydrocarbons. These serve as "building blocks" which are then upgraded to more valuable commercial chemicals by polymerization, by combination with other organic chemicals, or by reaction with oxygen, chlorine or other inorganic chemicals. Figure 6 gives some examples, chosen at random, of this sort of progression from petrochemical raw material through a simple hydrocarbon "building block" to a more complex intermediate and, finally, to a consumer product. These examples are typical of a broad classification in which a new compound is built around the structure of carbon atoms present in the original hydrocarbon.

The second and entirely different route from crude oil or natural gas to petrochemicals involves as the first step the reaction of the hydrocarbon source materials with steam or oxygen, or both, to give a mixture of carbon monoxide and hydrogen. Figure 7 indicates how this mixture, known as synthesis gas, may then be used as a source of hydrogen in the manufacture of ammonia, as a source of carbon monoxide for carbonylation reactions, or as the starting material for producing methanol and the Fischer-Tropsch type of product.

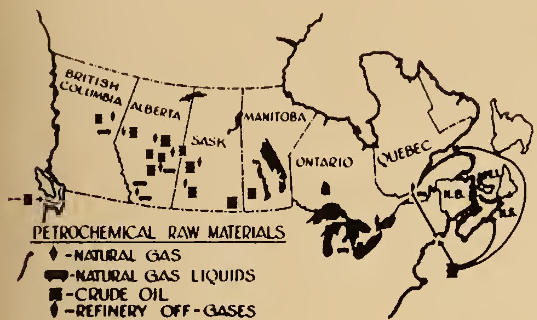
Like all attempts at classification, this breakdown of petrochemical processes into two major routes does not cover all cases. However, this will give some idea of the kinds of chemicals and the types of chemical processing involved in the petrochemical industry.

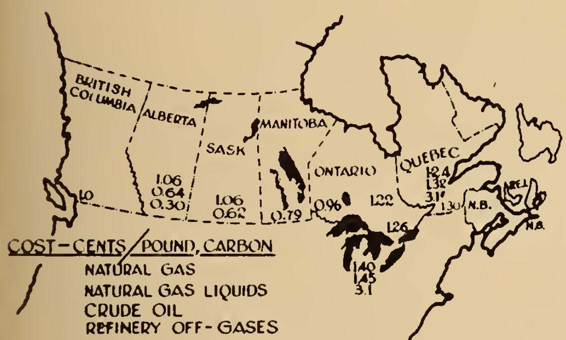
Pattern of Petrochemical Development in Canada

Let us now look at the pattern which petrochemical developments have followed in Canada. The initial stimulus came from World War II. As Figure 8 shows, an ammonia plant based on natural gas was built near Calgary in 1941 to increase supplies of nitric acid and ammonium nitrate for military explosives. It was converted later in the war to the production of fertilizers for the United Nations. In 1943 a fully integrated synthetic rubber plant based on refinery gases was built at Sarnia to supply general purpose synthetic rubber and butyl rubber for inner tubes. These were the first two petrochemical plants in Canada.

Development in the West—Figure 9 shows the most important post-war developments in the West. These include two more ammonia plants based on natural gas, one at Fort Saskatchewan to supply ammonia for use in the extraction of nickel and one at Medicine Hat as part of a large fertilizer plant. At Edmonton, ethane extracted from natural gas is cracked to ethylene which is then polymerized to give the plastic, polythene. Also at Edmonton, propane and butanes recovered at refineries or from natural gas are partially oxidized to produce a variety of chemicals including acetaldehyde, methanol, formaldehyde, acetic acid and acetone; some of these products are used with cellulose from British Columbia to make cellulose acetate for textiles, some are converted to more complex intermediates such as pentaerythritol, and others are sold without further conversion. Propane and butanes are also used as l.p.g. fuel and as feed materials in processes for making 100-octane gasoline. Sulphur, recovered as a by-product of natural gas purification, is now produced at several locations and goes to sulphite pulp mills or is converted to sulphuric acid for use in fertilizer manufacture at Medicine Hat and uranium refining at Beaverlodge. When gas exports start on a large scale, sulphur of petrochemical origin will be available in amounts which will exceed total Canadian consumption.

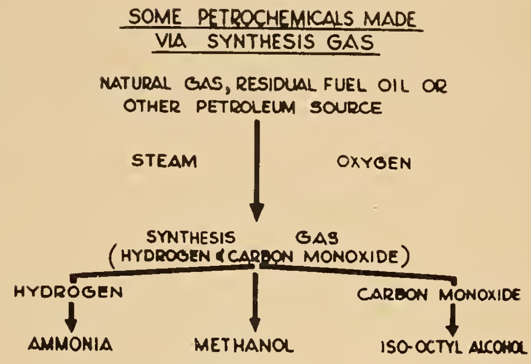
You will see that most of the petrochemical intermediates made in the West are used in conjunction with other local industries such as pulp, metal refining, and fertilizer manufacture. These petrochemicals are mainly low-cost products which cannot be shipped any great distance without freight costs assuming a disproportionately large part of the delivered price. Polythene is one of the few exceptions where the cost of shipping to the East is offset by the lower raw material and energy costs in the West.





SOME PETROCHEMICALS DERIVED FROM SIMPLE HYROCARBONS

RAW MATERIAL	PROCESS	CONSUMER PRODUCT
ETHANE (NATURAL OR REFINERY GASES)	CHLORINATION TO ETHYL CHLORIDE	TETRAETHYL LEAD
ETHYLENE (REFINERY GASES)	OXIDATION TO ETHYLENE OXIDE	GLYCOL ANTIFREEZE
BENZENE (NAPHTHA REFORMING)	ALKYLATION TO DODECYLBENZENE	DETERGENTS
ACETYLENE (NATURAL GAS PYROLYSIS)	HYDROCHLORINATION TO VINYL CHLORIDE	P.V.C. PLASTICS



WARTIME PETROCHEMICALS

LOCATION	RAW MATERIAL	PETROCHEMICAL	MAIN USE
CALGARY	NATURAL GAS	AMMONIA	FERTILIZERS, EXPLOSIVES
SARNIA	REFINERY GASES	BUTADIENE, STYRENE	GR-S RUBBER
		ISOBUTYLENE	BUTYL RUBBER

Left, top to bottom, Figs. 4, 5, 6. Right, Figs. 7 and 8.

Development in the East—The corresponding pattern of post-war petrochemical development in Eastern Canada is summarized in Figure 10. In most cases, the starting materials are refinery off-gases. These are used at Sarnia and Montreal East to produce petrochemical intermediates for use in manufacturing consumer products for which markets are to a large extent concentrated in Ontario and Quebec. The petrochemicals include styrene, ethylene and phenol for plastics; acetone, isopropyl alcohol and other industrial solvents; butadiene, styrene and other intermediates for synthetic rubber; ethylene glycol for antifreeze; and ammonia. The only major petrochemical operations in the East which are not based on refinery gases are: carbon black, made at Sarnia from a specially processed distillate; benzene and aromatic solvents made from catalytic reformate; formaldehyde made from methanol; and ammonia made from fuel oil. Tetraethyl lead for gasoline anti-knock fluid is manufactured from imported petrochemical intermediates, while the synthetic fibres, nylon and "Terylene", are manufactured in part from petroleum-derived materials not yet produced in Canada.

Growth and Value of the Industry

The growing importance of the petrochemical industry is shown in Figure 11, in which the gross selling values of the Canadian and United States petrochemical industries are plotted on a *per capita* basis. The corresponding figures for sales of all chemicals and allied products in Canada are also shown.

Two things stand out. In the first place, petrochemicals have been growing at a faster rate than chemicals as a whole; that is, an increasing proportion of chemicals production is being made from petroleum raw materials. In 1947, 24 million dollars' worth of petrochemicals were produced in Canada, equivalent to four and one-half per cent of the value of chemicals and allied products. By 1955, 127 million dollars' worth of petrochemicals were made, equivalent to twelve per cent of the one billion dollars' worth of chemicals and allied products. All the past experience suggests that petrochemicals will continue to grow more rapidly than the rest of the chemical industry.

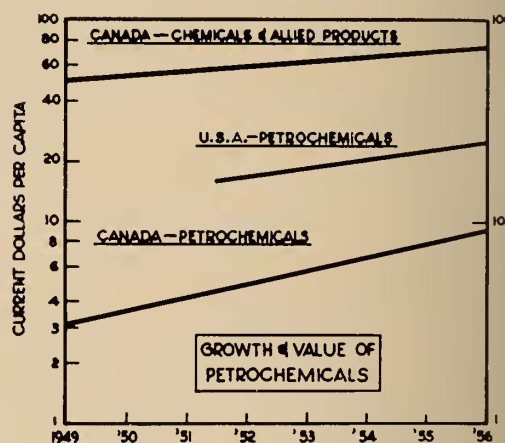
The second point is that in 1955 consumption of petrochemicals per person was nearly three times as large in the United States as in Canada. Over 50 per cent of total chemical production in the U.S.A. was from petroleum raw materials compared with 38 per cent in Canada. This suggests that the future market opportunities in prospect for petrochemicals in Canada are exceedingly bright. However, as I shall be discussing later, there are certain factors which may retard the rate of growth of the petrochemical industry in the future.

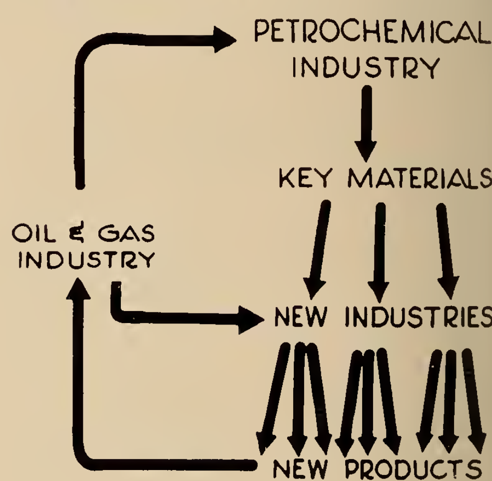
POST-WAR PETROCHEMICALS IN THE EAST

LOCATION	RAW MATERIAL	PETROCHEMICAL	MAIN USE
SARNIA	REFINERY TAR	CARBON BLACK	RUBBER
SARNIA & MONTREAL EAST	REFINERY GASES	PHENOL, STYRENE ACETONE AMMONIA ISOPROPYL ALCOHOL ETHYLENE GLYCOL	PLASTICS SOLVENTS FERTILIZERS GASOLINE ANTIFREEZE

POST-WAR PETROCHEMICALS IN THE WEST

LOCATION	RAW MATERIAL	PETROCHEMICAL	MAIN USE
MEDICINE HAT	NATURAL GAS	AMMONIA	FERTILIZERS
EDMONTON	NATURAL GAS	AMMONIA	NICKEL REFINING
EDMONTON	NATURAL GAS	ETHYLENE	POLYTHENE
EDMONTON	NATURAL GAS BY-PRODUCTS	ACETIC ACID	CELLULOSE ACETATE
SEVERAL ALBERTA LOCATIONS	NATURAL GAS BY-PRODUCTS	PROPANE & BUTANE SULPHUR	L.P.G. FUEL & GASOLINE PULP, URANIUM FERTILIZERS





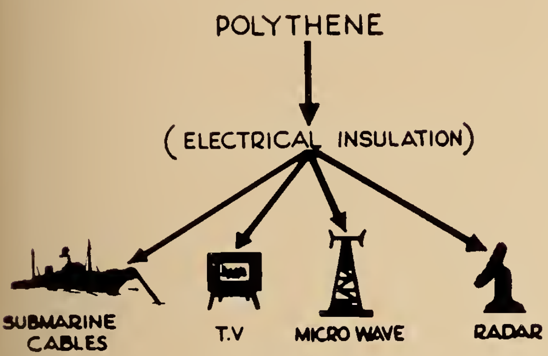
Left, top to bottom, Figs. 9 and 10. Right, Figs. 11 and 12.

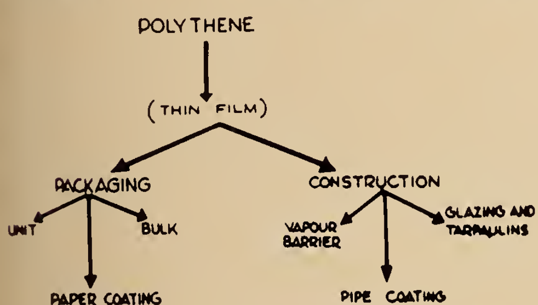
Scale of the Petrochemical Industry Relative to the Oil and Gas Industry

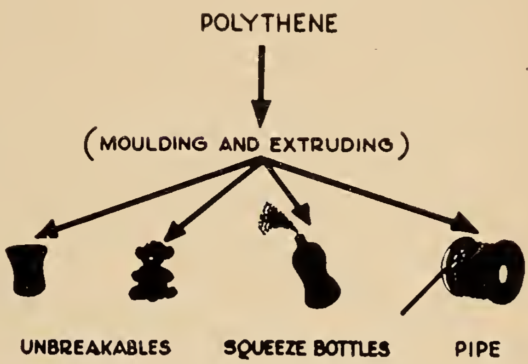
To keep the picture in perspective, I would like to make a further comparison, that of the relative sizes of the petrochemical industry and the oil and gas industry. The 127 million dollars in sales of the petrochemical industry in 1955 was only about 12 per cent of the combined value of the products of the nation's oil refineries and natural gas producers. This may lead one to believe that petrochemicals play a relatively insignificant role in the national economy, but in actual fact the impact of petrochemicals on Canada's industrial development has been much greater than these figures might suggest. This is because of the relationships illustrated in Figure 12, which result in a sort of "economic leverage". I use this term to describe the process whereby one new industry, which produces key materials with novel or unusual properties, brings about the founding of a number of other new industries. These, in their turn, not only bring more new products to the market but also demand goods and services from existing industries. For example, when the oil and gas industry supplies a raw material which leads to a new petrochemical enterprise, it also supplies its usual fuels, lubricants and other products to the new enterprise and to the secondary activities which are brought into being. In addition, the products of the new petrochemical development may be of benefit to the oil and gas industry, such as oil-resistant plastic pipe and synthetic rubber hose. The diagram does not show the whole story, since the new industries also require cement, steel, machinery, financing, advertising, and so forth. This "economic leverage" is a sound way to stimulate expansion in our national economy and I would like to illustrate its effect by two examples.

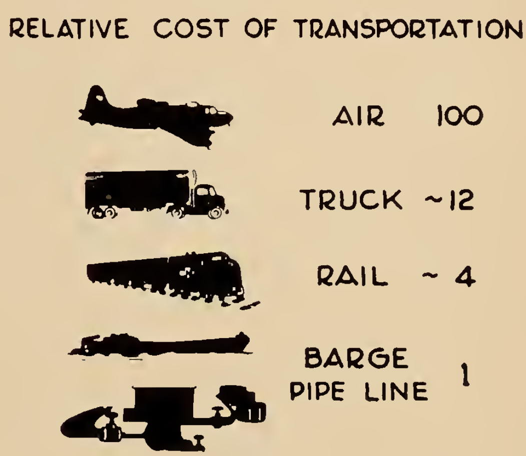
One of the key petrochemicals is ethylene, which is extracted from refinery gases or is made from ethane, propane, or sometimes oil. Ethylene can be oxidized to a very reactive petrochemical called ethylene oxide. This material in turn gives rise to numerous new products, including ethylene glycol for antifreeze, explosives and polyester fibres; polyethylene oxides for synthetic lubricants, waxes, and detergents; and glycol ethers which are specialized solvents. It can be converted into acrylonitrile which is used in oil-resistant synthetic rubbers and for synthetic fibres such as "Orlon"; and into ethanolamines which are widely used to remove hydrogen sulphide from natural gas and refinery gases. This versatility is typical of petrochemical intermediates, and it is almost certain that a material such as ethylene oxide will find expanding uses in the future .

My other illustration is another derivative of ethylene, this time the plastic called polythene. Polythene is now a familiar material to all of us, but imagine the situation when a few years ago the first sample, a rather dirty waxy material, was put on a research director's desk. Is this important, or just another trivial discovery? This sample might have ended up in the waste-paper basket or might have been relegated to the dusty recesses of a cupboard. However, its properties were investigated, and it was found to have unusually good electrical insulating properties and resistance to moisture, and was thermoplastic. Its unique electrical insulating properties at very high frequencies proved to be the key to success in the use of radar in World War II, and Figure 13 shows some of the other developments which have since followed.









Above, Fig. 13 (top) and 14. Right, Figs. 15 and 16.

Further experiments showed that thin films could be made from polythene. After much patient work and the development of novel techniques, a new, tough, transparent wrapping material came on the market. Figure 14 shows its uses. You are all aware of the revolution in packaging which followed, and will have noted how this has stimulated the use of other packaging materials. Ready availability and lower manufacturing costs have now resulted in other uses for polythene film, particularly in the construction industry, where it is used as a moisture barrier and for temporary glazing.

As shown in Figure 15, the plastic nature of polythene has been turned to full advantage by moulders and extruders, often with remarkable ingenuity; and the day may well come when the plumber is more familiar with polythene than with traditional metal pipe!

Hindrances to Growth

These examples show why the petrochemical industry may justly be called a growth industry. It is not only growing itself but is stimulating growth in other industries. However, this growth can be, and in fact is being, hindered by a number of factors. Since we are approaching a time when a considerable surplus of oil and gas raw materials will become available, especially as by-products in western Canada, it is important to understand what these hindrances are and how they operate. Growth can be retarded by unrealistic pricing of raw materials, inadequate tariffs and the perennial problem of freight costs.

The danger of retarding growth by asking too high a price for oil and gas materials has recently been demonstrated, and wisely avoided, in connection with the Trans-Canada natural gas pipeline. To make this project feasible, the price paid to the producers had to be negotiated downwards. It seems likely that as the market for natural gas builds up, the return to the producers will improve, but the important thing is that the parties concerned were willing to modify their terms so that, in consequence, natural gas will move. The same sort of willingness will probably be necessary to develop further outlets for oil and gas by-products in petrochemical manufactures.

Of all the hindrances to the expansion of the petrochemical industry (in fact, of the whole synthetic organic chemical industry), the tariff situation is probably the most important. No one wants tariffs for the sake of tariffs! What the petrochemical industry wants is a market for its products large enough to sustain plants of economical size. A market of this size is denied to many petrochemicals by the high tariffs and currency restrictions of other countries, coupled with low tariffs on imports into Canada. The United States tariffs on most synthetic organic chemicals range from 10 per cent to 45 per cent ad valorem, as compared with 20 per cent or less on imports of the same items into Canada. However, plastics and many key organic chemicals only qualify for 7½ per cent or less. Moreover, manufacture in Canada does not automatically mean that a higher tariff applies. The need for tariff protection for Canadian petrochemicals arises because, in present circumstances, the relatively small Canadian market must be shared with producers in other countries; at the same time there are only limited opportunities for Canadian producers to export to the other countries. Therefore, it is quite often very difficult, or impossible, to justify a plant of economical size in Canada.

The justification for the policies of some other countries may be found in the past history of their own synthetic organic chemical industries, which includes most of the petrochemical industry. In the United States, the Fordney-McCumber Tariff Act of 1922 gave tariff rates of 25-60 per cent to many chemicals and this allowed the establishment of an organic chemical industry in spite of the large, efficient European producers of that period. Undoubtedly the resulting higher prices created some burden which had to be borne by the economy as a whole, but the vigorous development of the American chemical industry since then has led to lower prices, greater variety of products, and a tremendous stimulation of other American industries.

Similarly, the organic chemical industry was established in the United Kingdom behind a key industry duty of 33-1/3 per cent ad valorem. The titles of the two Acts of Parliament establishing this duty are revealing: the Safeguarding of Industry Act of 1921, and Dyestuffs (Import) Regulation Act of 1920. These acts were the result of British experience in World War I and were intended to create a synthetic organic chemical industry in the face of competition from the well-established German industry. Subsequent experience clearly showed the value of these protective moves.

These two examples from the history of other countries show that, although the help of tariffs in establishing and promoting the growth of an industry such as the petrochemical one may create some initial difficulties, the long-term benefits and far reaching effects more than outweigh the initial difficulties because of the process of "economic leverage" I described earlier.

It is true that, in spite of an unfavourable tariff situation, the petrochemical industry has become established in Canada. Nevertheless, rapid as its growth has appeared, you have seen from the figures presented earlier that it is still far behind its United States counterpart in relation to overall national development. The fact that petrochemicals have so much room in which to grow as part of a balanced expansion of the Canadian economy is very heartening when one thinks of the surplus of natural gas by-products which will soon be appearing in the West, and of the increasing reserves of crude oil and natural gas seeking markets in most parts of the country. But this growth and diversification will not continue at the rate it should, and oil and gas products will not find their way into chemical products, unless tariff legislation is enacted and suitably enforced to ensure a market big enough for Canadian ventures. I would like to refer to Figure 12 to show the direct and indirect effects on the oil and gas industry if petrochemicals are imported into Canada rather than manufactured here. Not only does the petroleum industry fail to gain a customer for petrochemical starting materials, but it misses out on sales of its other products both to the petrochemical plant and to the secondary activities stimulated by the petrochemical plant.

Freight Costs—A superficial look at the western oil and gas fields invites comparison with the Gulf Coast and may lead to the assumption that, say, Edmonton will become the petrochemical centre of Canada. This overlooks the fact that the Gulf Coast has direct access by water to most of the main market areas of the United States, as well as to other world markets. Alberta has no such advantage and Figure 17 illustrates why this is so important. It shows the relative costs of transportation by pipeline, barge, rail, truck and air. Transport by rail or truck costs several times that by barge or lake freighter; the only available method of transportation from the West comparable in cost to water-transport is pipelining, and pipelining is restricted to the large-volume movement of fluids. The distance from Alberta to the markets in Ontario and Quebec is around 2000 miles, compared with 1000 miles from the Gulf Coast to Ontario, so that even apart from water transportation, Alberta is at a disadvantage to the Gulf Coast in terms of access to the major Canadian markets.

In discussing the cost of shipping materials across central Canada, we should distinguish between petrochemical starting materials and finished products, since the differences will affect the choice of plant location. In the first place, the basic oil and gas raw materials can, for the most part, be moved economically by pipeline, whereas the finished products cannot; a crude oil pipeline is already operating, a natural gas pipeline is under construction, and a liquid products pipeline is in the planning stage. Secondly, most petrochemicals contain oxygen, chlorine, nitrogen or other elements as well as the carbon and hydrogen derived from the oil or gas raw materials. These all add to the weight, and make it more expensive to ship the finished products instead of the raw materials. Finally, the railway freight-rate structures are set up in such a way that the higher-value finished products and intermediates cost more to ship than the low-value raw materials. Because of these factors, petrochemicals for eastern markets tend to be manufactured close to the markets rather than close to the raw material.

I hope that these remarks have illustrated the factors which can hinder progress in petrochemicals, and have underlined the need for all parties concerned — raw material producers, manufacturers, and governments to cooperate to the greatest extent to allow a healthy diversification of the petrochemicals industry.

Future Opportunities

What of the future? In the East, increased refining capacity will result in more refinery by-products but these are unlikely to keep pace with demand. New units are being installed to make petrochemical raw materials directly and to a large extent independently of refinery operations. At Sarnia, a special cracking unit is under construction to provide ethylene, propylene, butylenes, butadiene and other "building blocks" for chemical products. Another plant has started the manufacture of benzene and aromatic solvents. These projects are based on crude oil. It is unlikely that natural gas will be used extensively as a source of hydrocarbon materials in the East, as gas is not expected to have any price advantage over alternative sources. If plans go ahead to move natural gas by-products, such as propane and butane from West to East by pipeline, they will be welcome new sources of petrochemical raw materials.

In the West, the surplus of the natural gas by-products will pose s

(continued on page 1287)

Impact of Western Oil and Gas on the Canadian Economy

C. O. Nickle, M.P.

Publisher, "Daily Oil Bulletin", Calgary, Alta.

Address to the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June 1957.

A STORY IS TOLD of a dear old Irish lady who one day arrived at the Canadian-American border, after a short holiday in the U.S. She was greeted by the Canadian customs man with the usual question "Have you anything to declare?" Smiling, and with a twinkle in her eye, she replied "No sor, I have nothing to declare." At that moment her coat fell open, exposing to view the neck of a bottle. "What have you there," cried the customs man, and the old lady's eyes sparkled, she smiled and said, "Why, 'tis but holy water."

With that the customs man grabbed the bottle from beneath her coat, yanked off the cap, took a healthy swig, followed by a second, and then a third. "Holy water, me eye," said he. " 'Tis whiskey". With that the old lady's eyes turned heavenwards, her eyes twinkled anew, and a beautiful smile came over her face. "Glory be," cried she, " 'Tis a miracle."

That story has something in common with the subject of my address tonight, for the story of Western Canada's oil and gas industry is closely related to movements over the 49th Parallel of capital and know-how one way and products the other; and can be properly described as something of a real life, modern day miracle. To bring the miracle, God-given natural resources have been matched with faith, guts, know-how and capital of modern man, both Canadian and foreign.

Canada's decade-old and continuing boom has been built around the collective impact on our economy of several great natural resource developments, from one end of the nation to the other. Among them are: the iron ore development of Northern Quebec and Labrador; the Kitimat aluminum and power development of British Columbia; major expansion of new base metal resources in New Brunswick, Ontario, and Manitoba; the emergence of Canada as one of the top sources of uranium for the atomic age world; and the emergence of Western Canada as one of the great Western Hemisphere sources of petroleum, natural gas and their by-products.

"In terms of new capital invested, new employment created, breadth of impact on the national economy, and degree of changeover of a vast section of Canada . . . to a diversified economy, Western oil and gas can be classed as the most important of the decade's resource developments in our country."

In terms of new capital invested, new employment created, breadth of impact upon the national economy, and degree of changeover of a vast section of Canada from a one-crop to a diversified economy, Western oil and gas can fairly be classed as the most important of the decade's resource developments in our country. Even more important is that this development is still at its early stages. Its overall impact on the Western and Canadian economies will continue expanding in the decades ahead —provided economic and political climates remain favourable—to a level many times greater than that of today.

The two Canadian communities where the impact of oil growth is most apparent are the two major cities of Alberta. For the past decade their metropolitan population increase has made them the two 'fastest growing' communities in all Canada. Each is a case history of what happens when human ingenuity discovers and puts to use resources so vast as the oil and gas hidden beneath the prairies and foothills of our West.

Calgary, for half a century a farming and ranching centre whose citizens carried their 'frontier gambling spirit' into leadership among Canadians in pioneer oil wildcatting, has capitalized on that pioneering by making itself the "administrative headquarters" for almost all companies participating in the widespreading Western oil play. As "Canada's Oil Capital", Calgary has doubled its population in a decade, now has over 207,000 souls in its metropolitan area, and continues to add about 1,000 people per month.

New office buildings are rapidly changing its skyline, as scores of oil firms expand administrative facilities for their Western Canadian operations. Today these Calgary offices are manned by some 6,000 men and women—executives, technical experts and juniors—with a local payroll of about $30,000,000 yearly, and still growing. Through direct employment, and through the new demands created for a host of human needs from groceries to homes, clothing to automobiles, the expansion of the oil industry is credited directly and indirectly with well over half of Calgary's growth.

Though oil administration needs provided the foundation, Calgary is growing to a new maturity of diversified industries in manufacturing, catering to its own and Southern Alberta's expanding population. Over the next few years, increased oil refining capacity and new plants for the processing of natural gas and gas by-products will bring further strength to the Foothills City.

Edmonton, Central Alberta's major city, to whose citizens dreams of oil were until ten years ago just an example of Calgary wishful thinking, has become Canada's fastest growing community (a percentage point or two ahead of Calgary) because of fulfillment of the oil dreams. The Imperial-Leduc discovery 30 miles southwest of Edmonton in February 1947 was the spark that set fire to and began the blaze of international interest in Western Canadian oil and gas prospects, just as many years earlier the Turner Valley field near Calgary had spurred many small Canadian companies and a few large ones to the search that led to Leduc.

Leduc brought intense exploration, and discovery of a string of oilfields around Edmonton. Within a few short years Edmonton grew into the West's No. 1 oil refining centre, and No. 1 centre of petrochemical and gas-processing plants. Within a decade population doubled, to a present 240,000 souls for the metropolitan area. Oil equipment depots, warehouses, and new manufacturing plants to serve needs of the oil industry and the growing population of Central Alberta and the far north country were built, and are still abuilding. District exploration and production offices helped bring on a wave of office building construction in downtown Edmonton. As with Calgary, Edmonton population continues to grow at around 1,000 per month—with oil, gas and their by-products directly and indirectly responsible for over half of the expansion.

But these two cities are far from being the only examples of municipal growth because of oil and gas. Devon and Drayton Valley, two of the West's newest, most modern 'big towns', have in recent years been created in Alberta in the centre of major oilfields, Leduc and Pembina. The little city of Red Deer, doubled in recent years by discovery of oilfields in its vicinity, is looking forward to further growth as the site of the West's first butadiene plant, soon to be built by the Polymer Corporation, based upon by-products of oil and gas. Medicine Hat has started a new industrial growth as the site of Northwest Nitrochemical's ammonia fertilizer plant. Jumping Pound, Turner Valley, and Pincher Creek, once small ranching centres, are now locations of large gas-processing and sulphur plants. Okotoks, and a string of other small Alberta communities, are slated for similar industrialization over the next two years.

In Saskatchewan, Regina has begun a large expansion as district headquarters for a fast-growing oil development in the southern half of the "Wheat Province", and as a major oil refining centre. Lloydminster, Moose Jaw, Weyburn, Estevan, Saskatoon, and other Saskatchewan communities are growing with the oil boom. In Manitoba, Winnipeg, Brandon, and Virden are gaining from the impact of oil exploration, production or refining operations in their vicinity. In British Columbia's Peace River region, communities like Dawson Creek and Fort St. John are bursting at the seams from oil and gas discoveries that are now being tied into markets, and within a few months Taylor Flats will start a career as a gas by-product and sulphur production centre to begin the region's industrialization.

Industrial Growth

This community and industrial growth is among the measures of the impact of oil on Western Canada. It is visible evidence to be seen in scores of localities scattered over a quarter of a million square mile region. Other visible evidence is the host of oil or gas fields, the number of which is being increased by one hundred or more per year; and the host of individual productive wells, now over 12,000 in number, and being added to now at over 2,500 per year.

The immensity of what is taking place in Canada's West can perhaps best be conveyed by contrasts—the picture of ten years ago with that of today. Since Leduc's discovery set off the boom, the rate of new capital investment in the many phases of oil and gas had climbed from one million dollars per month to over $1½ millions per day. The population in the West supported directly or indirectly by oil and gas has climbed from about 25,000 to over 300,000.

Production of oil has increased about thirty times, from 19,000 to over 560,000 barrels per day. Oil potential—the ability to produce if transport facilities and markets permitted—has increased by 47 times, from 19,000 to over 900,000 barrels daily. Proved reserves of crude oil have increased by 54 times, up from 65 million to about 3,500 million barrels. Natural gas production has tripled to over 200 billion cubic feet yearly, but will soon start a far faster expansion with completion of the first great gas transmission pipelines. Proved natural gas reserves have increased eleven-fold to about 24,000 billion cubic feet—and will likely show a faster growth now that markets are being made available.

As you see, there has been a sharp contrast so far between the rate of growth of gas as compared with oil. This is primarily due to the sharp difference, in recent years, between the Canadian public and government attitudes towards these twin resources. Oil has been comparatively free to grow into markets, anywhere within economic reach regardless of international boundaries, with economic not political considerations being main factors in pipeline route and refinery locations. Implicit is recognition that freedom to market the greatest possible volume of oil provides the best guarantee of incentive to discovery of more and more of these resources. In other words, the best guarantee against shortage in the future is sale of enough oil now at best possible prices to provide revenue for bigger and better exploration.

The wisdom of this policy is evident. In a decade production has skyrocketed to thirty times its 1947 level. Gross revenue from oil production—only $16,000,000 a year a decade ago—hit $400,000,000 in 1956 and may pass half a billion dollars for this year, making oil Canada's No 1 source of mineral wealth. Yet discovery rate of new reserves is being maintained at 2½ times or more the rate of production—thus giving ever more security for the future.

At the time of Leduc's discovery only 418 miles of oil pipeline served Canadian fields. Within three years the 1,150 mile Interprovincial Pipeline connected Alberta fields with the head of the Great Lakes at Superior, Wisconsin, and as reserves increased this line became the world's longest, by extension over American territory to Sarnia, Ontario. This year the line becomes a 2,000 mile system by extension on to Toronto. In 1953 the second major oil pipeline system (Trans-Mountain) was built connecting central Alberta to Vancouver and Puget Sound, over the Rocky Mountains. Today a great network of feeder pipelines link these systems with oilfields in Alberta, Saskatchewan, and Manitoba, and with growing refining centres on both sides o the International border, all the way from the Pacific Ocean to Toronto. Today's oil pipeline network totals some 6,000 miles, and represents a $600 million investment. It is being steadily expanded to keep pace with needs.

The first major gas pipeline was proposed in 1948, almost nine years ago, but this and subsequent gas proposals soon became bogged down in a gumbo of public misunderstanding of gas economics, conflict between competing pipeline interests, and political battles. During the years oil grew into Canada's No. 1 revenue mineral, natural gas and its by-products grew into the nation's No. 1 'shut-in' resource.

Finally, two years ago, the barriers to gas development began to crack. Westcoast Transmission Company gained final approval for a pipeline system linking Peace River region gas with the Pacific coast, including approval to enter the vast U.S. Northwest market without which the project sadly lacked economic feasibility. The Westcoast system is now near completion and will go into operation within a few months. Plans for a gas pipeline east from Alberta, denied by political considerations the freedom to grow by stages into nearby Canadian and U.S. markets first, then into Eastern Canada later by the most economic international route, became a battle royal. A year ago came compromise between political and economic realities, involving a measure of government assistanee to overcome the deficiencies of a Northern Ontario pipeline route, and priority for the far-distant Eastern Canadian market. Frustrated owners of Alberta gas reserves—pressured by a $150 million investment in non-revenue producing gas-wells—helped very materially to get the compromise project underway by agreeing to supply gas at low initial prices. Today the Trans-Canada gas pipeline is under construction, will reach across the Prairies later this year, and as far as Montreal by the end of 1958. It will be the world's longest, most costly gas pipeline, about 2,200 miles in length, and around $400 million in cost.

With completion of these first major gas pipelines a new era in gas development and Western industrialization will get underway. With the incentive of markets, it is probable that Western Canada's known gas reserves will be proved up at a somewhat faster rate than the average 3,000 billion cubic feet yearly of recent years, and will thus far more than keep pace with market demand. Over the next few years the capacity of the initial west and east pipelines will be expanded, as markets are developed for gas in Canada and nearby U.S. areas. In addition, a new major pipeline link from southern Alberta through the Crows Nest Pass into the U.S. Northwest has recently been proposed, and will likely be given approval without the long battle that beset the earlier projects. Over the next five years, gas pipelines serving Western fields will likely catch up in mileage with the oil systems of today, and this long-idle Western resource, natural gas, will become a vital fuel for millions of homes across a broad belt of North America, and an important factor as fuel and raw material for a wide range of manufacturing industries across the continent.

Gas Processing

To the West, 'big scale' gas usage will mean far more than merely exploration for and production of this hydrocarbon. Much of the gas reserves that will supply the major pipelines will be drawn from fields containing wet, sour gas. From this must be stripped hydrogen sulphide, which in turn is processed to yield elemental sulphur. From the raw gas must also be stripped natural gasoline, propane and butane; constituents valuable for liquid fuels, and as raw materials for an ever widening range of products of the petrochemical industry. The stripped dry gas, largely methane, goes to the pipelines. Like some products stripped from it, methane is both a fuel and a basic raw material for chemical processes.

Over the next few years, therefore, a string of new gas processing and sulphur plants will be built in various Alberta and Northeast British Columbia gas fields, supplementing the several already in operation or now under construction. The West's production of sulphur, natural gasoline, propane, and butane will be expanded by several hundred per cent, and will result in major expansion of the western petrochemical industry, in the phases where it is economically feasible, to assist in putting these by-products of gas to use. End result will be a host of plants, big and small, widely distributed over the West, creating new local industry and employment, and adding to the diversification and strength of the Western and Canadian economies.

Let us look at one by-product of wider gas usage: sulphur. From a small beginning a few years ago, the West's sulphur production will reach a rate of 200,000 long tons yearly this Fall. By the end of 1960 sulphur production will probably be somewhere between 1,000,000 and 1,500,000 long tons annually—moving Canada up to a place second only to the United States among the sulphur-producing nations of the free world. This sulphur expansion will be important to many Canadian industries, including pulp and paper, uranium and base metal refining, and chemical. In the offing, however, is need for large-scale foreign markets for our sulphur, in the United States and overseas. I trust this export development will be patterned like our oil growth, avoiding the problems that for so long beset our natural gas.

The petrochemical industry has already involved a $140,000,000 capital investment in Alberta, because of recent years' oil and gas growth, and will undoubtedly further expand in this province and in other parts of the West. Biggest operation today is Canadian Chemical Company's cellulose acetate and organic chemical plant at Edmonton, drawing raw materials from nearby oil and gas fields. Also in the Edmonton area is Canadian Industries Limited polyethylene plant, and Sherritt-Gordon's ammonia nickel-leaching plant, the latter a successful mating of Manitoba nickel ore resources with by-products of gas in Alberta. Calgary now has its big C.M. & S. ammonia fertilizer plant, based on Turner Valley gas and by-products, and the area is soon to get two new sulphur plants. Northwest Nitrochemical has recently placed in operation a large ammonia fertilizer plant at Medicine Hat, combining American phosphate rock with southern Alberta sulphur and gas to serve agricultural needs on both sides of the international boundary. Next big project coming up will be Polymer Corporation's butadiene plant at Red Deer, which will use components of central Alberta wet gas to produce for the first time in the West the basic material for Polymer's synthetic rubber and chemical plant at Sarnia, Ontario. The years ahead will bring other additions as the economics of production, processing, transport and marketing permit in the broad field of petrochemicals, ranging through synthetic fibres and rubbers, plastics, paints and resins, synthetic detergents, nitrogen compounds, and automotive chemicals. But it is also apparent that economics will dictate that a sizeable percentage of gas by-products will have to be transported in raw form to Canadian and foreign areas far distant from fields of supply, but closer to major areas of petrochemical consumption.

Let us look now at some other measures of the impact of past and future oil and gas development on our nation's economy. First, the flood of capital investment into all phases, from exploration, production, transport and processing of the hydrocarbons, which directly and indirectly benefits every citizen and industry of our nation. In just over ten years, capital investment has mounted to nearly four billion dollars. Over the next ten years new capital investment—economic and political climate being favourable—will be between six and seven billion dollars. Over the next 20 years, it could exceed twenty billion dollars.

Second, our international trade balances, which are favourably affected in three ways by the oil and gas development. One of these is inflow of foreign capital (nearly two billion dollars the past decade, and expected to be 300 to 400 million dollars annually over the next few years) a major offset to our unfavourable trade balance with the United States. Another is the rapid progress towards self-sufficiency in balance in hydrocarbon resources, which cut nearly two billion dollars from Canada's dollar needs for imported fuels over the past decade, will save over half a billion in foreign exchange this year, and increasingly larger amounts in years ahead. The third is earnings of foreign dollars from export of some of our oil, gas and by-products. From a small beginning, these earnings rose to over $100 millions in 1956, may exceed a quarter of a billion dollars this year, and will become progressively larger. Every Canadian is better off because of this giant assist towards equalizing of Canada's import and export trades.

A third measure of impact is cost saving to Canadian consumers of fuels, made possible by development of the Western resources. It is estimated that the annual petroleum products bill to consumers in the areas now served by domestic oil would be some $100 millions greater if these Canadians had to depend upon higher-cost imported oils. On the Prairies, for example, gasoline, tractor and other fuels would be from five to seven cents per gallon higher in price, if the market had to be served with imported fuels.

Another measure of impact is the revenue added to treasuries of the various levels of government in Canada as a result of the oil growth, thus reducing taxation burden on others paying into those treasuries. The past decade's gain to governments has been around one billion dollars, with Alberta's treasury getting the lion's share so far (over $635,000,000), and the balance being shared by the Dominion and by Municipal and other Provincial governments in the west. As owners of mineral rights, Alberta and other western provincial governments get their major benefit from fees, rentals, royalties, and cash bonuses paid for these resources by the oil industry. The Dominion government cut comes from corporate and personal income taxes and these will skyrocket in years ahead, as the oil industry generally advances from the return of capital to the profit stage in its producing operations. The Municipal government revenues come from property taxes and other assessments. These too will continue to expand as the physical assets of the oil, gas and by-products industries grow in Canada. As a reasonable guess, government treasuries in Canada will collect somewhat more than two billion dollars the next decade because of the oil and gas development.

Less Dependent on Imports

A fifth measure of impact is the lessening dependence of Canada, and of North America, upon oil supplies drawn from overseas areas, via ocean supply lines, subject to curtailment or cut-off in time of emergency. Western Europe learned the hard way a few months ago its degree of dependence upon Middle East oil. Europe's oil crisis was alleviated by calling on surplus producing capacity in the United States, Venezuela and Canada. In World War 2, North America and its allies all learned that military success depends upon fuel for industry and armament, and adequate supplies when and where needed are essential. The growing oil and gas potential of Western Canada has, therefore, in recent years, become an important factor in the national and mutual defence planning of our own country and our southern neighbour.

To cover in adequate detail the economic impact of Western Canada's oil and gas, recent past and future, on Canada's economy would require far more time than available for a single speech. From some of the highlights I have discussed, it is apparent that impact of the growth has already been great; but has been small compared to what lies ahead in future years.

By 1980 I believe that the 700,000 square miles of geologically favourable territory of Western Canada will be producing oil, gas, and by-products with a field value of around three billion dollars yearly; will be supporting directly and indirectly in Canada somewhere between two and three million of the population of the greatly expanded nation; and will rate among the most important factors in the overall economy of our country.

Is the forecast too optimistic? Let's call on the report of the Royal Commisson on Canada's Economic Prospects (the Gordon Commission) for another judgment, based upon its recent studies. Says the Commission:

"Perhaps the most striking single thing about the forecasts of Canada's steadily mounting energy requirements is that by 1980 between two-thirds and three-quarters of a greatly increased total will be supplied by petroleum and natural gas. In both of these commodities Canada will on balance be more than self-sufficient. This is a very different picture from that of 1926, when petroleum and natural gas accounted for about one-eighth of the total energy consumed, and when almost all petroleum products were imported. The projection of demand for natural gas suggests in fact that its consumption may increase ten or more times within the 25-year period. It is clear from these figures that Canada's future economic development will depend to an increasing extent upon its resources of these fuels."

The Gordon Commission report continues: "The size of our domestic requirements is of course only one of the determinants of the rate of growth of the Canadian oil and gas industry. The first and most important factor is that the oil and gas be there to find and develop. There is every reason to believe that the geology of the interior plains region of Canada stretching from the United States border into the Northwest Territories is favourable to the discovery of large amounts of oil and gas, and that our prospective reserves should be more than sufficient to meet any demand in Canada in the future.

"The Commission's study suggests a possible level of production in 1980 substantially above forecast domestic demand. The potential output of oil in 1980 is estimated at about ten times 1955 production, and between 1½ times and twice the anticipated Canadian requirements of 1980. For gas, the potential output is estimated at over 15 times 1955 output, which would be about 50% more than expected domestic requirements in 1980."

The Gordon Commission thus envisages Canadian oil production in 1980 of some 3,500,000 barrels per day, compared with Canadian consumption at that time of between 1¾ and 2¼ million barrels daily. It envisages Canadian natural gas production of some 3,000 billion cubic feet in 1980, with Canadian markets absorbing around 2,000 billion cu. ft.

The Royal Commission concludes: "This means that there will be large quantities of oil and gas available for export. If we continue to import oil into Quebec and the Atlantic Provinces, the quantities available for export from the Prairies will be correspondingly greater. Should these exports be realized, our net export surplus by 1980 in oil and gas alone would be over one billion dollars per annum compared with an excess of imports over export in 1955 of $340 millions."

It is a rosy forecast, one whose fulfilment is important to you and me and all other Canadians, and to the Canadians of the next generation. The basic ingredients of resources, know-how and capital are available—provided we supply adequately the fourth vital ingredient in years ahead. I refer to incentive. If we provide the encouragement of sound government economic policies; fair but not excessive taxation with specific emphasis upon encouraging more Canadian investment in resources; if we keep the door open to capital, know-how and manpower from other nations able and willing to assist in building a greater Canada; and if we fully recognize the value to our nation's future of freedom for our resources to grow into both domestic and foreign markets in the most economic pattern; then we can be sure that incentive will join with the other basic ingredients in realizing the high hopes for the future of Western Canada's oil and gas resources.

Petroleum Refining

(continued from page 1276)

to the scene of the fire, if one should occur.

All parts of the plant are normally shut down at least once annually, to inspect the condition of equipment and repair it or clean it, if necessary. A high standard of maintenance is essential if the efficiency of the plant is to be maintained, and continually more effort is being placed on preventive maintenance.

Future Probabilities

The market for petroleum products will continue to grow in leaps and bounds, but the refiner will be faced with increasingly competitive conditions, which will force him to look ever more closely at his operating efficiency. This will require even greater automation of plants than exists currently.

Due to changing market conditions and the gradual lessening of the bunker fuel market, processing equipment will have to be installed to produce more total white products and less residual. In doing so, more light gases will be produced, which will have to be processed into a stable fuel, since the economics will not allow them to be burned in the refinery fuel system. As time goes on, the quality of crude available to the refiner will gradually decrease, so that new refineries will have to be better equipped with alloy steel to resist corrosion, and more equipment required to turn each barrel of crude into the same percentage of total white products.

In case some of you here today worry about the future when we will run out of oil, and consequently out of gasoline to run our motor cars, I would like to remind you of the very interesting plant which has just gone on stream recently in South Africa. This plant is called Sasol, and is located inland not far from Johannesburg. The plant is extremely complicated and I will not go into the detail of processing sequence and complexity of equipment. From a charge stock of 3,050 tons per day of coal, available at the plant site at a cost of 75c per ton, gasoline at the rate of 4,000 bbl. per day, plus middle distillates, fuel oil, wax, various kinds of alcohol, liquified petroleum gas, benzol, toluol, tar pitch, and waxes are produced. I am sure that the oil refining business will continue to be a fascinating one, and that the younger engineers will continue to find the solution to the perplexing problems which crop up continually in the changing supply and demand.

The Petrochemical Industry

(continued from page 1282)

vere problems. While further uses in petrochemicals will come along if favourable conditions develop relative to prices, tariffs, and transportation costs, the petrochemical industry cannot possibly consume any large fraction of them, and they will have to find outlets in fuel and energy uses, such as l.p.g. and high-octane gasoline. Looking as far as the West Coast, petrochemical ventures there will probably arise only if export markets are developed.

New processes may be expected which will increase the role of petrochemicals used in the extractive industries. Natural gas will find uses in the pulp industry both as a fuel and as a raw material for ammonia manufacture. The Sherritt-Gordon process of using ammonia to extract nickel from its ores is now well-known, and new processes are currently being developed to reduce other ores to the metal by means of reducing gases made from natural gas. With iron ore in southern British Columbia existing so close to cheap natural gas, the need for coke as the reducing agent may be eliminated. This could lead to a new type of iron and steel industry for western Canada.

Conclusions

This summary of the Canadian petrochemical industry will, I hope, have emphasized its versatility, its rate of growth, and its key place in our national economy, particularly in promoting sound and long-continued growth. Its task in the future is to provide still more of these key materials we call petrochemicals, and by research and development to foster the best use of this nation's raw materials, brainpower, and practical skills. This growth will not be easy, but if the problems of raw materials, tariffs and freight can be overcome, then hard work, cooperation and a determination to succeed, will ensure that the petrochemical industry duplicates the achievements of the Canadian oil and gas industry.

DISCUSSION

of Technical Papers and Other Articles

THE PROBLEM OF STREAM POLLUTION (A PANEL DISCUSSION)

L. Piché, D. Jones, AFFIL. E.I.C., H. H. Clare, D. S. Kirkbride, M.E.I.C.

The Engineering Journal, 1957, July, p. 985.

The following verbal discussion and comments were recorded during the panel session on stream pollution referred to above.

Question: Dr. Piché stated that in survey of the Ottawa River a close check on pH of the surface water was made in parallel with the B.O.D. and coliform bacteria content determinations. Was there much variation in pH at the various locations along the Ottawa River?

Answer (Dr. Piché) — pH index is not on the same footing as B.O.D. and coliform bacteria concentrations. It is a useful indication of the dilution of acidic or alkaline effluents. Normally, the pH does not tend to vary very much in a river unless a very extraordinary factor exists. In the Ottawa River survey, every sample was examined for pH but I can see nothing that can be gathered from a study of the pH variation. Nevertheless, in the specific case of acid or basic waste, the pH is an indication of the pattern of dilution of that waste, otherwise, the B.O.D. dissolved oxygen and coliform determinations present a more reliable means of measurement.

Q. (Mr. Owens). Mr. Jones, in your talk you referred to the Gauvin "Atomized Suspension Technique". Would this have applications in pollution abatement other than the purification of waste sulphite liquors?

A. (Mr. Jones). We do know a little bit about the potentialities of this process in the treatment of waste sulphite liquors and have wondered if this technique could be applied to the disposal of municipal wastes. However, as Dr. Gauvin is present tonight, I will ask him if he would care to elaborate further on this subject.

Dr. N. Gauvin M.E.I.C. There is much interest in this problem and undoubtedly investigations will be undertaken, but as yet nothing has been done and immediate consideration is not possible due to the present number of problems on hand. However, it is our intention to build a reactor which will be devoted almost solely to this purpose and which will treat sizable quantities of laboratory and pilot plant effluents. The problem is tremendous due to the low calorific value of sewage — about 3500 B.t.u. per gallon and it is normally desirable that the process be self-sufficient from a fuel point of view. Of course, if it can be successfully applied to this problem, then all that would be returned to the stream, for all practical purposes, would be distilled water and I am sure there would be no objection to that. The answer is, however, premature at this time, there is a possible application but whether it would be successful I cannot say.

Comment (Mr. Asselin, City of Montreal) — It is interesting to learn that, even without all the necessary legislation, industry is beginning to tackle the Waste problem. Since public funds must be used for municipal improvements, public interest and good will are essential and it is also interesting to read of the work of the Anti-Pollution League towards the education of the public in this pollution problem.

The treatment of municipal wastes introduces special problems in that the sewage must first be collected and brought to one point for treatment, since the economics of the operation would not permit a multiplicity of plants. As many as ten communities may have to combine their wastes for treatment in one economically sized plant. This produces many problems other than the technical, in fact the technical problems may be the easiest to solve. A great deal of co-operation is necessary and tremendous sums of money are required merely for the building of the collection systems.

Some progress is being made on this problem in this area. The north side of the Island is already supplied with a grid of eight sewers which were built at a cost of five million dollars each or a total of $40 million for a collection system. The plant has yet to be built.

Q. (Mr. Owens). Dr. Piché, could you give any idea of the costs of operation of a municipal treatment plant for the treatment of municipal and industrial wastes?

A. I have no personal experience in that field, but Dr. Berry, Chairman of the Ontario Pollution Control Board, has stated that the cost would run 25 to 35 cents per week per household for operation and amortization costs over a 20 year amortization period.

Comment (Mr. MacDougall) — I would like to point out one of the basic problems associated with pollution control. Although legislation is necessary for the control of pollution and will eventually be developed, the big problem is how this is to be applied so that there will be a rational approach to the use of water as a national resource which must be used and not abused. This involves the setting up of pollution standards. This cannot be done in "gros" but has to be specific to the particular problem involved. For example, I know of one place where a large steel mill was built on a river above a large city. The water in this river was very clean and it was obvious from the beginning that the standards would be very high. In fact the standard finally set up was that the water returned to the river should be of the same quality as that received. This is probably the ultimate in standards. If, however, you try to apply such a standard to the western part of Pennsylvania you could run into many absurdities. If you said that it was wrong to put alkaline wastes into the Allegheny River which is heavily surcharged with acid from mines it would be foolish, for in this case an alkaline discharge would be a value.

Standards are thus a very essential part of the problem and must be made so that they consider the needs of both industry and the public. These must be developed by co-operative effort for irrational and unreasonable standards, if once established and publicized, can become part of public thinking and great difficulty would then be experienced in changing them.

The most earnest thinking should, therefore, be devoted to setting up of standards which would not be injurious to anyone.

Comment (Mr. Clare). When Imperial Oil proposed to build a refinery near Winnipeg, on the Red River, Provincial authorities demanded that the water from the refinery should contain no more than 5 ppm. of oil. This was 10 ppm. less than the river already contained and meant that the refinery would be recovering oil from the Red River. This represented mostly service station refuse and had Manitoba continued to insist upon such a standard, the refinery could not have been built and this would have cost the citizens of the Winnipeg area about $2,000,000 a year, representing the decreased cost of gasoline that was passed on to them.

Q. As a representative of the Chemical Industry, I have listened with a great deal of interest to this discussion, however, I also have in the back of my mind my hobby of game fishing and I would like to ask a question, not of a highly technical nature. Dr. Piché said a little about the effect of oxygen on various game fish and I would like to ask him what variety of fish I could hope to catch in water that is only partly polluted?

A. (Dr. Piché). From my understanding, by discussions with biologists water saturated with oxygen (8 to 10 ppm.) will sustain fish such as trout and bass. Reduction of the oxygen content below 8 ppm. would cause a change in the species of fish present in the water and "coarser" varieties would likely be found.

Comment: (Dr. Piché). In discussions on stream pollution an accusing finger is frequently pointed at industry. I think that industry has been extremely co-operative and I see no reason why they should be placed on the defensive on this subject. One can easily point to a number of specific cases where industrial managements have been splendid in their consideration of the pollution problem. C-I-L, for example, in their studies of new plants have made elaborate surveys of the eventual consequences of pollution of neighboring streams. The Pulp and Paper Industry has tremendous technical problems but has already made spectacular achievements in dealing with the effects of pollution. The treatment of waste sulphite liquors to produce alcohol at Gatineau has had the effect of reducing the oxygen demand to 25% that of raw waste sulphite liquor while the B.O.D. is reduced to about 10% of its normal value by the utilization of sugars contained in these liquors. Again, in Quebec sulphite liquors are upgraded to a saleable product by the Lignosol process.

The problems that we have are not new, they have been encountered and splendidly managed elsewhere. Twenty-five years ago the Thames and Seine Rivers were badly polluted, yet today they are very agreeable rivers servicing heavily populated areas. Some such progress has already been made in this country. The improvement in the St. Claire river which is shown in some aerial photographs I have seen is quite spectacular and should be seen by anyone concerned with this problem.

Comment (Mr. Jones). In Sweden at present every sulphite pulp mill operates an alcohol plant and a chemical plant which manufactures potable alcohol and a number of chemical derivatives from waste sulphite liquor. Similarly, Swedish sulphate pulp mills operate chemical plants which produce talloil, turpentine and other chemicals. Potable liquor can not be made from waste sulphite liquor in Canada and even if this were possible, it would be economically unsound for every mill to produce alcohol. There are two industrial alcohol plants associated with pulp and paper mills in Canada and one mill produces Lignosol from waste sulphite liquor. The mills of the industry are constantly searching by research for products which might be produced from waste sulphite liquor or as by-products of the sulphate pulping process which could find a volume market. Such a general solution to this problem would likewise tend to reduce pollution from Canadian pulp mills.

Q. In the mining areas of Quebec and Ontario many of the streams are contaminated by cyanide from the mines and earlier I asked Dr. Piché a question related to pH since in these areas the pH of the waters is closely associated with their condition.

Dr. Piché, in his talk appeared to be principally concerned with bacteriological conditions. Mr. Kirkbride mentioned that legislation had been passed in Ontario to the effect that water must be returned to a stream fit for use as drinking water and other uses. In the use of ground waters, with which I am concerned, we feel that water after it has filtered through the ground will always be safe from a bacteriological standpoint, but if chemicals are present the water is, in many cases, unfit for further treatment and I wonder if you make a distinction between bacteriological and chemical contamination.

A. (Mr. Kirkbride). I would like first to clear up a point of misunderstanding. The International Joint Commission in its studies of boundary waters in the Detroit and Niagara rivers set forth objectives, which they felt should be achieved in those waters, and I believe are what you referred to when you mentioned legislation passed in Ontario. I made the point that these objectives are good and that we can expect to see them become the standards which will eventually have to be met in all areas.

As regards chemical contamination, it is pollution as much as anything else and sooner or later mills that are putting streams in the condition you describe will be required to treat their wastes and return them in a way that will leave the water suitable for other purposes. Dr. Berry, Chairman of the Ontario Pollution Control Board, gives a definition of pollution that is interesting: "Pollution and contamination in technical terminology refer to those conditions in water which result from the introduction of pathogenic organisms, toxic materials, or any other substances which depreciate the natural quality of the water to such an extent that its usefulness is impaired or it becomes offensive to the senses." *(Eng. Journal* 1955, Sept., p. 1181)

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

SILICONES IN THE PROTECTIVE COATINGS INDUSTRY

H. L. Cahn, *ASTM Bulletin*, No. 222

Many applications of silicone products as protective coatings are indicative of a rapidly advancing silicone technology. High heat-resistant enamels, additives for correcting surface film defects, anti-foaming compounds, electrical insulating coatings, and masonry water repellents are among the many silicone products.

The classic example of the use of silicone resins is in high-temperature aluminum paint. Here the vehicle is 100 per cent silicone resin and it gives a paint with the greatest utility in service at temperatures up to 500 F. It can be used at temperatures up to 1000 F. or higher but actually a less costly paint can be compounded containing only 50 per cent silicone resin. This is because the solids of a silicone resin are only slightly volatile at 500 F. under long exposure and a heat-stable resin is necessary. At higher temperatures even the silicone is volatilized while the aluminum film becomes fused to the steel. Therefore only enough of the silicone vehicle is used to set the aluminum film in place. Aside from metal pigmented coatings, white and coloured silicone paints and enamels can be used for adequate protection under specified service conditions. Home incinerators and reflectors for certain types of lights that generate much heat are coated with straight silicone or high-silicone content enamels. Coloured and iridescent metallic finishes are used to provide decorative as well as protective coatings for space heaters, ovens and other items subjected to elevated temperatures in normal service. The principal requirement of these finishes is heat resistance, but other factors such as colour, film integrity, gloss, etc., must be constant. High silicone content copolymers have been developed for service slightly less rigorous than that for which pure silicone resins are used. White enamel finishes on kitchen range parts which are exposed to fumes and steam and temperatures up to 350 F. frequently turn yellow under ageing while porcelain areas remain white. However, white enamel finishes based upon high-silicone copolymers with the proper organic intermediate will withstand such conditions and remain white. Hardness, mar resistance, flexibility, soap resistance, vegetable fat and fruit juice resistance have made such finishes valuable in the field of household and kitchen appliances. For basically the same purposes where a lesser degree of heat resistance is required low silicone content blends and copolymers are performing a valuable service. Coatings containing up to 25 per cent of total solids as silicones have markedly improved weather resistance and substantially upgraded heat resistance compared to the 100 per cent alkyd-base finishes.

Coatings for electrical equipment have the primary purpose of protecting the insulation which is already present. They keep out dirt and moisture. However they also must have some insulation value and usually must pass a dielectric strength and resistance to carbonization on exposure to arcing. They also are capable of satisfying tests for corona degradation. This is an electrical phenomenon wherein charged particles present in voids in electrical insulation bring about the formation of ozone and nitrogen oxides which rapidly degrade most insulation materials. In many cases the proved heat resistance of silicone insulation has permitted the doubling of the power output of a given motor frame size. Because of the thermal stability and extended high-voltage endurance of silicone materials, heavy-duty power cable with insulation fabricated from silicone rubber-coated glass cloth has doubled the power-carrying capacity.

Used in ratios of a relatively few parts per million, silicones are amazingly effective in performing specialized corrective functions. In varnish and resin cooking processes and in latex and latex paint manufacture serious foaming problems can be controlled. Flotation of tinting pigments in paint manufacture can be corrected by silicones and they also serve other purposes such as a pigment wetting agent and an antisilking agent.

Probably the fastest growing application of silicone materials in the protective coatings industry is the use of silicone water repellents on masonry. A water-soluble silicone, sodium methyl siliconate, is the only material which has been found satisfactory to make limestone water-repellent. This material cures upon exposure to carbon dioxide in the air. It is gaining increasing use in its application to roadways, piers and abutments of concrete highway bridges because of the freeze-thaw stability that it imparts to concrete. The light reflectance of wet concrete is greatly improved by treatment with this water soluble silicone and it finds use in highway construction. Minimizing or completely eliminating efflorescence on masonry walls, as a result of absorption of external water, is another advantage to be gained from the application of a protective silicone water-repellent coating.

The accelerated pace of engineering technology is constantly creating the need for coatings having properties which the silicone materials can provide. Consequently there is a growing list of specifications for finishes incorporating significant quantities of silicone products.

PAPERS PRESENTED TO BRITISH ENGINEERING INSTITUTIONS

The Institution of Civil Engineers

Shaft Raising in the Scottish Highlands
R. S. Henderson (No. 6190)

This paper describes a new method of raising a high-pressure shaft for a hydro-electric power station, necessitated by the great depth of shaft—one of the deepest in the United Kingdom. The method used was entirely different from the timbered stope or normal sinking, and eventually involved initial drilling of a 6-in. dia. hole 600 ft. deep with a maximum error of 2½ ft. to 3 ft. The shaft is the penstock to the St. Fillans section of the Breadalbane power scheme in Scotland.

Initial setting was done by concreting in a 20-ft. pipe as drill casing, which was set up very accurately. Photographic equipment was installed in the drilling head at various depths to record any deviation; during drilling, tests for verticality were made every 25 ft., and any errors were corrected by using whipstocks. Drilling took three months and was within 2 ft. of vertical when finished.

A special stoping cage was designed, with particular attention being paid to safety precautions. This cage, roughly a cylinder with conical ends, held a crew of two and was hoisted from below to the drilling face by a wire rope passing through the 6-in. drill hole to a headgear at the top of the shaft. After drilling (compressed air) and stemmining the face with explosives, the cage was lowered and stowed away before firing. This procedure was repeated at an average drilling time of 2 hours, charging time of 30 min., and travelling to and from the face 1 hour, including stowing the cage. Smoke clearance (1 hr.) and handling rope and cage (1 hr.) gave a complete round in 6 hours. Actual rate of progress was 64 ft./week, with a maximum of 138 ft. in one week, in the latter stages, when conventional methods would have been slowest. The penstock shaft was finally enlarged by drilling and firing from the top.

The paper mentions certain technical difficulties, such as the effect of water on the telephone system, and makes recommendations for future use of the technique.

The work was carried out by the Mitchell Construction Company on behalf of the North of Scotland Hydro-Electric Board.

RESEARCH IS LIFEBLOOD OF AVIATION

R. Hotz, *Aviation Week*, v. 66, no. 22

Without a constant flow of new technical data being supplied to the industry by research workers, the vast machinery of the largest single manufacturing industry in the United States would soon come to a halt. No other industry, with the possible exception of nuclear energy development is more dependent upon swift sure technical progress for its future than aviation. No other industry has raced through its technical spectrum so fast during the past fifty years. It is important to realize that only 54 years after the Wright's fabric, spruce, and wire biplane rose from North Carolina sand dunes using a 12 h.p. engine and hand carved wooden propellors, man has flown faster than 2100 m.p.h. and reached an altitude of 126,000 ft.

To support this terrific pace of technology the aviation industry and agencies of the federal government have built a vast organization of skilled technicians and modern research facilities. Research and development in aeronautics and its supporting sciences has grown to a multi-billion dollar annual effort and shows no signs of stopping its phenomenal growth. The aircraft industry today is ploughing 13% of its sales dollar back into research and development, which is the highest ratio of any major U.S. industry. This vast effort embraces the resources of the Air Force, Navy, and Army, the industrial complex of the nation's largest single manufacturing industry and the skills and laboratories of the university system.

Research and development programs devoted to aviation and its related sciences face many acute problems in fulfilling the basic function of providing a sound technical foundation for future development of the industry. Most acute is the need for continued expansion at a rate which will exploit fully the many new technical areas opened up as a result of earlier research. These efforts by their nature are dynamic progressive processes and do not fit easily under an artificially imposed budget ceiling. Each major technical area opened by basic research creates a whole new family of problems that must be solved if fruits of a major technological break through are to be harvested efficiently. Also, it should be remembered that this research and development effort provides a technology which enables general industry to create new products for both civilian and military applications.

In place of the fallacious "constant budget level" policy that now dominates government controllers of research and development programs, a more realistic financial approach is required, geared to the creative character of research effort and with full recognition of the effects of dollar inflation on the absolute scale of research results.

The rapid pace of technical development also has produced an acute need for new types of research development facilities such as hypersonic wind tunnels, pressure and altitude engine test cells, solar furnaces, nuclear material testing reactors, supersonic sled tracks and captive missile test stands. Neither planning nor implementation of major government construction programs have kept pace with these requirements. Demand for hypersonic and missile re-entry data already was acute before shocktube and multi-stage missile test vehicles were available to produce it. Ram-jet engines, rocket engines, exotic fuels and ballistic missiles were ready for experimental testing before adequate test facilities were designed, built and properly instrumented to handle them.

Basically, government philosophy has been to confine its research and development facilities investment to projects too costly for industry to build or operate as individual firms. However, industry has found that using government development facilities, particularly for early experimental work, exacts too heavy a time penalty in the stiff competitive race for contracts. As a result most successful firms have invested heavily in their own development facilities. Virtually every major airframe contractor has his own supersonic wind tunnels. All major engine manufacturers have built large jet engine development laboratories. One company is building a new research centre covering research in hypersonics, aerodynamic heating, nuclear development and helicopters. Also, university facilities are increasingly important in research and development.

Although the government is now spending over a billion dollars annually for research and development (about 60% of it with industry) there is a strong trend to get industry to shoulder a higher percentage of the overall costs with its own money. For competitive reasons industry would prefer this type of operation but before it can be effective there must be basic revisions of government cost regulations in this field.

There is great need for a sound research and development program for this vital industry to realize the full potential of the "air age".

WORLD'S LARGEST EXPERIMENTAL GENERATOR IN SWEDEN

Bureau de Presse Suedo-International, Stockholm, June 1957

The large Swedish manufacturers of electrical equipment, ASEA, are replacing their existing high-voltage laboratory at Ludvika (in service since 1933) with a new installation. The original laboratory was one of the most advanced in the world and included a 1000 Mva. generator, which will still be used. The new equipment will include a generator rated at 2500 Mva.

It will be possible, by operating the two generators in parallel, to do experimental work at about 3500 Mva. and at potentials up to 13 kv. Special transformers will be installed to give facilities for tests up to 2000 Mva. and 145 kv. At higher voltages, the three-phase power will fall off, but it will be possible to use the laboratory facilities for single-phase tests up to 250 kv. or with limited power up to 360 kv.

Many other facilities will also be installed in the new laboratory, which will be almost tripled in area. The whole program is due to be completed in 1958.

TRACTOR OPERATED BY REMOTE CONTROL

Tests have recently been carried out at the U.S. Army Research and Development Laboratories, Fort Belvoir, Va., on a radio controlled tractor. This is believed to be the first application of remote control to construction equipment, and one application may be to carry out construction work in radioactive and combat areas. From a jeep or helicopter equipped with a standard military radio transmitter and a special control box, an operator can start and stop the machine, engage and disengage the gears, manipulate a dozer blade, and steer the unit. Normal operations can be done from distances up to 15 miles, the practical range of the radio, though initial tests were done with the tractor and control point within visual range. It is possible that small television cameras installed on the tractor would enable the operator to work the unit without the need for intermediate observers. (Photo: Le Tourneau-Westinghouse Company; permission Dept. of the Army, Washington, D.C.)

ELECTRICITY IN FRANCE

***French Economical and Technical Bulletin*, No. 1., 1957**

The main sources of electrical power in France are coal (65%), oil (20%), and hydroelectric plants (15%). Natural gas, only recently discovered in France, may play an increasing part in this scheme. Comparative figures for world averages are: coal 53%, oil 29%, natural gas 10%, and hydroelectric power 7.8%; and for the Western European countries as a whole: coal 75%, oil 16.6%, natural gas 0.6%, and hydroelectric 7.8%. These figures show a relatively high proportion of hydroelectric power in France.

Post-war plans for power production have emphasized the need for adequate supplies to meet industrial and other needs. Hydroelectric sources show a slight predominance over thermal production, mainly because conventional fuels are not readily available. Almost all petroleum supplies are imported (25 million tons in 1955, compared with a domestic production of one million tons); nearly 30% of the 74 million tons of coa used in 1955 was imported, and about the same proportion of total French power needs are supplied by imported products.

In 1955, thermal power stations operated by nationalized and private industry produced 24.1 billion kwh. an increase of 13% over 1954. The figures for 1956 should represent a doubling of thermal power production since 1947. Fuel efficiencie have been improved considerably in recent years, the latest plants recording an average of 2650 calories pe kwh. compared with 4960 cal./kwh in 1948. Thermal production from liquid fuels has shown an increas of some 20% between 1947 and 1954 with a comparable figure of 10% fc gaseous fuels.

Hydroelectric power in 195 amounted to 25,575 million kwh. (13 045 million kwh. in 1947), and represents a 5.3% rise over 1954. Th increase was limited by a sever drought during the last half of 195 Installed capacity of hydro-electr equipment rose from a total of 3,743 000 kw. in January 1946 to 7,874,00 kw. at the same date in 1956. Annu production capacity more tha doubled during this period, from 13 733 billion kwh. to 28,308 b. kwl

Distribution networks have deve oped to meet increasing demands ar to reduce transmission losses, whic represented some 11% of power r quirements in 1955. Between 19 and 1955 various networks were extended as follows: 90-kv. circuit from 2050 miles to about 3200 miles; 150-kv. from 3300 miles to 5700 miles; 225-kv. from 1280 miles to 6000 miles. The 110/120 kv. circuit, which extended 826 miles in 1938, has been converted, and 650 miles of 225-kv. lines have been installed to handle up to 380 kv.

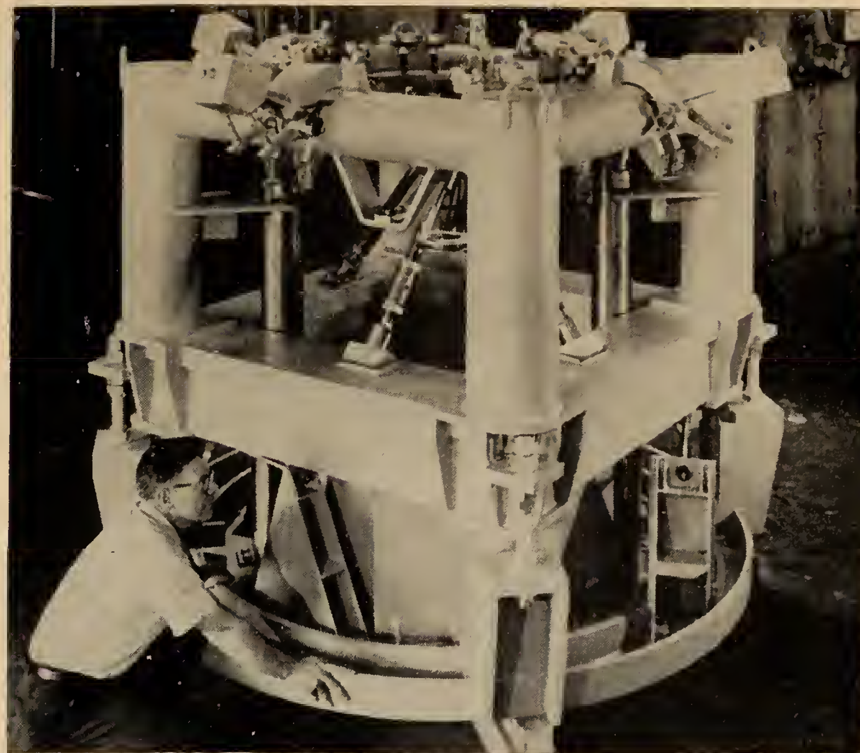
Future developments in France include hydro-electric projects on the Rhone, Rhine, Isere, and Durance rivers and thermo-electric production from 26 new groups with an average capacity of 115,000 kw.

Future developments may lie in newer techniques such as gas turbines, power from ocean tides, and nuclear energy. A small experimental 1200 kw. turbine was installed in 1952 in the Rheims power station, and other work has been done in view of the development of natural gas deposits.

France has long been concerned with the production of power from the sea, and construction of a tidewater power plant is planned in the Rance estuary in Brittany. (A description of this project was published in the *Engineering Journal*, 1957, March, p. 301). By 1963, this plant should be in full operation and producing 800,000,000 kwh. a year.

The first unit designed to produce electricity from nuclear power was the G1 pile of the Marcoule plant, near Avignon, which went into operation early in 1956 with a capacity of 5000 kw. Two further piles, G2 and G3, are being built and will supply, respectively, 25,000 kw. and 30,000 kw. by late 1957 or early 1958. A 60,000-kw. plant, the EDF 1, is to be completed in 1959 in the Loire valley and will feed into the main distribution network.

Plans to meet expected industrial and domestic needs in 1965 are for 44 billion kwh, of hydro-electric power and 51-58 billion kwh. of thermal power, which would include 3 billion kwh. from nuclear sources. By 1957, nearly 200 billion kwh. may be needed, the hydro-electric potential may have reached its limit of expansion at some 60 billion kwh., and nuclear energy may have to supply much of the additional requirements.



STAND FOR IGY EARTH SATELLITE LAUNCHING

This firing stand for the Vanguard earth satellite rocket is a roughly cubic steel framework, measuring some 6½ feet on a side. The stand will be mounted on top of the launching platform and is designed both to test and launch the rocket. Provision is made for holding the 72-foot rocket exactly vertical, weighing the unit and its fuel, and measuring thrust during captive runs. More than twenty fuel and instrument lines have to be disconnected instantaneously at the moment of firing. The base of the stand houses a large flame deflector. The weighing and measuring equipment consists of four SR-4 load cells which support the rocket stand on a weigh ring; measurements of weight and thrust are relayed to a bank of recorders in a distant blockhouse. The stand is also equipped with floodlights, emergency spray nozzles for fire-fighting, a safety shower and emergency eye-wash fountains for the use of operators. The stand was designed and built by the Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp.

NIELS BOHR INTERNATIONAL GOLD MEDAL*

The Institution of Danish Civil Engineers

The Dansk Ingeniorforening instituted an international gold medal on Oct. 12, 1955, the occasion of Professor Niels Bohr's 70th anniversary. The medal is to be awarded every third year to scientists or engineers who have made important contributions to the peaceful use of atomic energy.

The first medal was presented to Professor Bohr himself at the inaugural celebrations, which have now been commemorated by the publication of an interesting book which contains the addresses given on that occasion by Professor C. Moller, representing the University of Copenhagen, President Anker Engelund, of the Technical University of Denmark, and Director Georg Dithmer, chairman of the Dansk Ingeniorforening.

Among his many associations with scientific societies, Professor Niels Bohr has been director of the Institute for Theoretical Physics at the University of Copenhagen, since its inception in 1920; president of the Royal Danish Academy and of the Danish Cancer Committee; and chairman of the Danish Atomic Commission.

The addresses pay tribute to Professor Bohr's outstanding work on the structure of the atom, which led to a new outlook on the physical principles involved and represented a departure from the classical theories of physics. This work was recognized by the award of the Nobel Prize in physics, in 1922.

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* Candidates for the award of the medal are to be nominated by members of EUSEC (Engineering Societies of Western Europe and the U.S.A.) The first committee for nominations consists of Prof. Bohr; E. Warburg, president of the University of Copenhagen; A. Egelund, president of the Technical University of Denmark; O. Rode, president, Dansk Ingeniorforening; and G. Dithmer, immediate past-president.

MACHINE LAID ASPHALT CURBS AND GUTTERS

A paper read by W. H. Schuelie and F. Swineford at the annual meeting of the Association of Paving Technologists, in Atlanta, Ga., in Feb. 1957, described the advantages of machine laid asphalt curbs and gutters, which are said to prove cheaper, easier and faster to construct, and more durable than those laid by hand methods. The machines described can place up to 2000 feet of curb in an eight-hour shift, depending on the operators' skill. The forward speed is from 4 ft. to 7½ ft. a minute. Guide lines are marked and a thin coating of rapid curing asphalt is applied to the cleaned surface to provide a bond between the pavement and the curb mixture. Hot mix asphaltic concrete, contained in a hopper, is extruded through a mould form under compaction pressure by a horizontal conveyor screw, driven by a small gasoline engine. The compaction pressure propels the curber forward. Operating crew is usually three men; one to guide the machine and two to keep the hopper filled. The paper gives several successful hot mix formulae for use with machine curbers. (Photo of the Stephens-Canfield model 55-A automatic curber, by E. L. Hardin Associates, Inc., Salisbury, N.C.)

MASS MOVEMENTS IN METROPOLITAN CITIES

Colonel S. R. Bingham*

A solution of today's transportation problems lies in the correct estimation of future travel demands; in knowing how to deal with them; what future patterns of land development and transportation facilities provide the most logical and complementary physical framework for regional prosperity; and what patterns of organizations and finances provide the most efficient means of obtaining and operating the desired physical patterns.

Attention must be given to plans for accessibility, fluidity of travel in the metropolitan area, recognition of the inherent relationships between the pattern of living and working areas and the connecting lines of communications. There must be an analysis of the fundamental processes of population and economic development. Existing systems of transportation must be reviewed. Needs and demands for a twenty-year period must be met. Air and helicopter service must be included as a matter of study.

Cost of monorail and subway facilities must be considered. The latter is however very costly, ranging from 8 to 10 million dollars per mile of track, compared to the monorail which at $500,000 per mile is not costly and can be erected quickly. It is versatile, utilitarian, and has aesthetic appeal.

If modelled after the Dallas, Texas, and Fort Lauderdale, Florida, installation, gasoline engines are employed to propel the car. The rail, a steel pipe, thirty inches in diameter is fastened to inverted "J" shaped towers, thirty feet high. Especially designed for high speeds, the towers can be constructed to any height. The rail is designed with the centre of gravity below the carrying point which permits high speeds with safety. Passengers are carried overhead between stations but are brought to ground level for loading and unloading. It is fast, efficient and comfortable. Designed for monorail and propelled by gas engines the coaches are both novel and attractive, and have proved popular from the point of view of public acceptance. The coach is 55 ft. long, 6 ft. wide and 8 ft. high. Seating 60, it can provide standing room for 50 or more, may be filled or emptied in 30 seconds, and operated on one level and underground for inter-city or central operations.

Locking wheels and locking guide rails make derailment impossible. Brakes are automatic electric and include "deadman control" braking which acts instantly if the operator's hands leave the controls.

Briefly mentioning an innovation in the field of transportation Colonel Bingham stated that he had developed the essential requirements of operations and equipment designs of the "carveyor" together with the engineers of the Goodyear Tire and Rubber Company and the Stephens-Adamson Manufacturing Company. Valuable as a medium of transfer or connection in loop operations, it adds another tool against the transit problem.

All corrective undertakings must however be planned and integrated with a regional master traffic plan.

* Col. Bingham is former chairman of the Board of Transportation of New York City, retired executive director and general manager of the New York City Transit Authority, and consultant for the St. Lawrence Municipal Bureau of the City of Montreal. This is a summary of an address to the Junior Section, Montreal Branch of E.I.C., given in April 1957.

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

Progress by NYSPA

July was marked by the peak placement of concrete for any one month with 177,000 cubic yards placed in all structures, bringing the total to date to 1,415,000 cubic yards or 69 percent of the total requirements. Excavation exceeds 43 million cubic yards. Employment averaged 6,470 for the month.

Concrete placement in the American half of the Powerhouse continued on schedule. Some 62,000 cubic yards were placed during the month, bringing the total to date to 701,000 cubic yards or 72 percent of the total requirement.

At Long Sault Dam, concrete placement was progressing at a rapid pace as approximately 72,000 cubic yards were placed in July, bringing the total to date to 336,000 cubic yards.

At Iroquois Dam, 12,000 cubic yards of concrete were placed in piers and roadway sections, bringing the total to date to 170,000 cubic yards.

Concrete operations at Massena Intake continued rapidly with 30,000 cubic yards placed during July bringing the total to date to 172,000 cubic yards. Placing of crushed rock blanket, riprap and embankment continued for the dike.

Channel improvement work at Sparrowhawk Point, Leishman's Point and at Ogden Island was progressing on schedule. The channel work was 80 percent completed. Topsoiling and seeding of Galop South Channel spoil areas was over 50 percent completed.

Clearing of the reservoir by three contractors was continuing on schedule with some 7,000 acres or 64 percent of the area cleared to date. All work under the original contract for clearing the Barnhart-Plattsburgh Transmission Line was completed. Construction of the line was continuing with unloading and hauling of materials and setting of poles for the structures.

Surfacing of Highway Route 37 was nearly completed and rough grading and embankment for Highway Route 37B were completed. Placement of concrete in abutments for the Franklin Road Bridge was on schedule.

Embankment and riprap were being placed on Richards Landing for the new Massena Beach. Selective

The Iroquois Dam. Looking upstream at Iroquois Dam in the foreground. Iroquois Lock on Iroquois Point, excavation of Iroquois Point at left, Toussaints Island and Sparrowhawk Point in the distance.

cutting operations were in progress along the Barnhart Island Access Road under the Park and Woodland Improvement Contract.

Progress by Ontario Hydro

Throughout the month of July, weather was generally favourable for construction work. The labour force totalled 5,250 persons. At the powerhouse, favourable progress had been made in concrete placing operations. A total of 680,000 cubic yards of concrete had been put into this principal installation by the end of July, with concrete for fifteen draft tubes having been placed to date.

Installation of mechanical parts was progressing well in the powerhouse. The speed ring for No. 10 unit was in place and the pit liner for No. 9 unit had been installed. Meanwhile, the frameworks for both the ninety-ton headworks gantry crane and for the three hundred-ton powerhouse main gantry crane, had been assembled.

All passenger and freight traffic during July was diverted to the new forty-mile section of Canadian National Railway main line between Cardinal and Cornwall, which will by-pass the area to be flooded by the power development next year. Freight traffic had been operating over this new section of double track for the past two months to consolidate the track and test all the automatic controls.

Removal of the old double track between Cardinal and Cornwall was started. This track is located adjacent to, and immediately north of, the river. Track removal was started first in the Mille Roche area where Cornwall Dike crosses the old railway line in three places.

It had been necessary to leave gaps in the dike construction until the old railway line was taken out of service. With the removal of these tracks, work got underway during the month on the closure of the gaps in the dike. Some 500,000 yards of compacted glacial till will be placed in the dike to close the gaps.

Foundation work was completed during the month for the northwest end of the dike in section No. 1. Dike building is being concentrated also in the area between the powerhouse and the Cornwall Canal closure structure, where filling and compacting are in progress.

In highway construction, with the completion of Hoople Creek bridge all detours had been eliminated on the diversion road between Cornwall and Iroquois. In another section of this work, the No. 31 Highway overpass was progressing favourably.

Channel improvement work progressed satisfactorily during the month. At Galop Island, the contractor was approaching the end of cleanup of the main cut through the island. A dredge was working upstream from the dewatered section of river bottom west of the island in preparation for breaching the cofferdam. By month end a total of some 13,500,000 cubic yards of earth and rock had been removed to form the new channel. At Point Three Points, the cofferdam had been completed. Work in this area was accelerating as the contractor proceeded on removal of the material in the Point.

The preliminary house moving program in Matilda Township was finished during the month with half of the homes placed on their new foundations.

House moving operations continued from the Dickensen's Landing area, to Ingleside, with seventeen houses moved during the month. In Ingleside, work was progressing on three churches, also the public and separate schools.

At townsite No. 2 (Long Sault), preparations were made for paving the roads. Work was advancing on the shopping centre with steel erection completed and exterior masonry work started. The new CNR stations at Long Sault, Morrisburg, Iroquois and Ingleside, were virtually completed during the month.

Much construction activity was underway in Morrisburg. The exterioi masonry for the shopping centre was nearly completed and interior partitions about 80% built. Some sixty units of rental housing were well advanced. At Iroquois, construction of rental housing also was continuing. Occupancy of units there will take place in August.

St. Lambert Lock, most easterly of seven new Seaway locks, upstream from the Victoria Bridge. The bridge carries double-track of the Canadian National Railways from Montreal to the South Shore of the St. Lawrence River. The lock chamber will provide a width of 80 feet, depth over sills of 30 feet and a usable length of 768 feet. Some 600,000 tons of concrete was required for this lock. The lift of the lock will be 15 feet.

Progress by SLSA

Work was accelerated on all sector of the Canadian navigation projec during the month of July, with employment at new peaks. Dredging and channel excavation continued on schedule. Work was well under way on dredging the channel north o Cornwall Island and on the approacl channel to Iroquois Lock.

Placing of concrete at the Iroquoi Lock was practically completed at en of July, with the upper sector gates i place and erection proceeding on th lower gates. Erection of steel for th roller swing bridge was progressin rapidly.

On the upper Beauharnois Loc 112,000 yards of earth and rock wer excavated in July, while 18,000 cub yards of concrete were poured, all in the upper gate area, bringing concrete to about 33 percent of completion. In the lower Beauharnois Lock 55,000 yards of rock and earth were moved in July and 40,000 cubic yards of concrete placed bringing total to date to 200,000 cubic yards or about 45 per cent of the total. One lane of the highway underpass under the lock was open for traffic.

At the Cote St. Catherine Lock 130,000 cubic yards of excavation was done during July, while 40,000 cubic yards of concrete were placed, bringing the total to date to 200,000 cubic yards or 70 per cent.

At the St. Lambert Lock 75,000 cubic yards of concrete in the chamber and upper approach were placed during July, bringing concrete to some 80% of completion. This established a record for concrete placed here in any one month. No work had yet been started on installation of gates. The collection sewer to serve Préville and Montreal South was about 60 per cent completed by month end, and the regulating channel about 40 per cent completed.

At the south end of the Mercier Bridge a half mile stretch of the seaway channel had been excavated by month-end. Footings for the lift span over the channel on the CPR rail bridge were completed and falsework for the span was being erected. Between the remaining portion of the original bridge and the channel crossing 11 piers some 100 ft. in height for the highway approaches on the south shore were completed, while on the south side of the channel another 28 piers were completed. On the higher piers the contractor was using the Swedish slip-form method of construction.

At the Jacques Cartier bridge, jacking of the superstructure spans continued between piers 3 and 13 to various heights ranging from zero at piers 3 and 13 to a maximum of some 8 feet at pier 7. Some 700 tons or 85 per cent of the steel had been delivered for the new through-span over the seaway channel, while floor beams and part of the girders had been erected on scaffolds on the upstream side. After the new span is rolled into place in November, it will be jacked up a further 25 to 30 feet. Work will commence in September on erection of highway bridge over the St. Lambert lock.

Contract Awards

SLSA readvertised its call for tenders for construction of control buildings at Iroquois lock in mid-July, to give contractors in smaller construction business a chance to tender. The work involves five buildings.

Workmen are dwarfed by the great walls of rock where construction of the lower Beauharnois Lock is under way. Here ships will be raised 42 feet into a canal about a mile in length which will lead them to the Upper Beauharnois lock and a second 42 foot lift, after which they will enter into the Beauharnois canal.

Seaway News

730 Foot Limit for Vessels using Seaway

All Great Lakes vessels now operating or under construction will be able to use the seaway when it is completed. But a few giant 'lakers' may be delayed at canal locks so as not to interfere with other vessels.

A joint announcement by SLSA and SLSDC on July 17 stated the maximum for normal operation would be a length of 715 ft. and a beam of 72 ft. However, ships 730 ft. x 75 ft. would be accommodated 'subject to appropriate scheduling and handling. The purpose is not to interfere with other traffic whenever the transit of such vessels is unduly delaying the transit of other shipping'.

The announcement does not change the picture for ocean-going ships, where the governing factor is the Seaway depth.

Bridge Below Montreal Island Advocated

Addressing the Rotary Club of Montreal on July 17, Dr. Pierre Camu of Laval University called for a bridge over the St. Lawrence river between Varennes and the eastern end of Montreal Island. He stressed the inadequacy of trans-river connections at Montreal and described the problem below the city as even worse. 'The Nun's Island bridge', he said, 'will improve the problem of linking the two shores, but I believe we should have asked first for the down river span. Industrial development of the south shore between Sorel and Boucherville demands it be built, even without considering local needs'.

Nun's Island bridge should be at least six lanes wide, he said, or if possible eight lanes wide. The future Hydro-Quebec plant at Heron Island could be planned to accommodate one-way vehicular traffic, leaving the Mercier bridge to carry traffic in the opposite direction. It was his belief that a tunnel should be constructed also to accommodate road traffic.

Contracts for some of the piers for Nun's Island Bridge have already been awarded, and other contracts relative to its construction will be let early in 1959, according to a statement by Transport Minister George Hees. No changes are contemplated in the plans affecting Montreal, for which decisions had been taken by the former government. Completion date for the bridge would be early in 1961, he said.

Richelieu-Hudson Deep Waterway

There are rumors that the Suez Canal Company may be interested in developing the Richelieu - Lake Champlain - Hudson Waterway. A deep-draught canal, lock and lake system would slice 1,200 miles off the Montreal-New York run for deep-sea ships, with enormous savings. Passage by slow freighter would be cut from eight days by sea to 3½ days through the waterway. It would tap a vast volume of seaway traffic from midwest U.S. and the Canadian industrial heartland.

The route at present runs 46 miles down the St. Lawrence from Montreal to Sorel, 14 miles up the Richelieu to the St. Ours Canal 1/10 of a mile long with draught of 12 feet and one five foot lock. Thirty-two miles further up it enters the 12 mile Chambly Canal with an 80 ft. lift in nine locks and a draught of 6½ feet, to Lake Champlain. From Lake Champlain it follows the Champlain Canal in the United States into the Hudson river. Total distance from Montreal to New York is 452 miles.

Today there is only one major commercial user, — Davie Transport of Montreal, which carries some 25,000 tons of newsprint yearly to New York, returning with general cargo. The company has seven vessels. Most of the traffic through Canadian canals is local, most of it fertilizer. In 1955 the system handled 97,000 tons compared with 109,000 in 1954. An announcement in mid-July that a new bridge over the Richelieu would be high enough to clear large ships has lent weight to the rumors, though no formal plans have so far been laid before either the Quebec or the Federal Government.

Cal-Sag Canal Expansion

Work was started in the fall of 1955 on the Cal-Sag improvement project, to widen and deepen the 16.2 mile connecting link between harbors of East Chicago and the Illinois waterway between the Great Lakes and the Gulf of Mexico. The first phase will be completed, according to present plans, in 1962.

With the Seaway open, the 60-foot width of the Cal-Sag canal would present a bottleneck. When the widening to 225 feet has been completed, two-way traffic will be continuous and the barge-tow will be raised from the present limit of two barges to four in tandem and two in width, —a length of 960 feet and a width of 70 feet.

An increase in barge traffic from the 4.6 million tons recorded in 1955 to 12 million tons in 1962 and to 18 million tons in 25 years is forecast. It is estimated that the cost of the project will reach $98.5 million, with the U.S. government carrying the bill for $80 million and the balance provided locally.

Seaway Control Battle in U.S.

SLSDC control of operation of the seaway is being contested by the Army Corps of Engineers. The argument was started by an unrevealed letter from SLSDC administrator Castle to the Army Engineers, notifying them their services "would no longer be required after 1958."

Mr. Castle maintains that the 1954 Wyley-Dondero Act gives SLSDC authority to build, operate and maintain the waterway. The army bases its case on a century-old body of law giving to army engineers control over all waterways from Panama to Sault St. Marie, and specifying that dredging, traffic control, etc., should be their exclusive province. The White House has handed the problem to Army Secretary Wilbur M. Brucker to find a middleground solution.

No Nearer Solution of Great Lakes Diversion Issue

U.S. legislation to divert another 1,000 cubic feet per second from the Great Lakes for a three year period, to see whether Mississippi River pollution would be lessened, has again been passed by Congress, and is expected to get Senate approval. President Eisenhower must then decide whether to again accede to Canadian objections and veto the bill for a third time.

Canada contends any diversion

The Long Sault Dam. The shape of the final structure is clearly outlined in this view of stage II construction taken from atop one of the gantry cranes.

would harm shipping and power production. Ontario Hydro protests the ɘxtra diversion would cut $500,000 worth of power production off annually in Southern Ontario. Reducing the flow would also lower water levels for shipping. Hydro contends the U.S. proposal to divert an equal amount into Lake Superior through the Long-Lac-Ogoke diversion is not possible.

Canada cannot block any U.S. plan o divert the water. But it can withhold approval of the scheme and eave the way clear for possible governmental court action in the event of damage to Canadian interests. Suit must be brought in a United States court.

Tolls

Toll committees of both countries are busy gauging public opinion on Seaway toll rates. The U.S. committee is scheduled to hold public hearings in September. In June the Canadian committee had already begun a series of informal meetings with shipping interests, and were asking for briefs. Discussions have already been held with the Canadian Shipowners Association and the Dominion Marine Association.

Total cost of the navigation facilities will reach about $450 million, of which Canada's share is roughly two-thirds and the U.S. share one-third. Amortization over 50 years calls for an annual capital payment of close to $10 million. Interest charges will add another $12 million and operation and maintenance a further $3 million; total annual charges $25 million.

Traffic estimates the first few years of between 31 and 36 million tons may increase by up to 15 million tons yearly. Committees hope a lower initial toll structure can be established to encourage traffic, even though revenue of $25 million would not be raised the first few years. But it is feared anti-seaway groups such as rail and road interests will insist on tolls from the first at rates to pay amortization and other costs.

Though both toll committees are thinking along similar lines, disagreement may appear later at inter-government level. Canada may want high tolls on iron ore and low tolls on wheat, while the United States may want the very opposite. Canada however has a $50 million trump card to play in the threat of creating an all-Canadian Seaway with additional locks parallelling the two American locks.

As for collection of tolls, the big problem is how to sort out the through traffic from the stop-and-go traffic, and how to assess tolls on tonnage which may change during passage through the seaway. Canadian-U.S. participation for collection of tolls based on roughly a two to one division of toll revenue is the probable solution.

ILA Threatening Control of Great Lakes Ports

A contest is brewing for union rights to organize and bargain for longshoremen at seaway ports from Toronto to Toledo, when the seaway opens in 1959. The International Longshoremen's Association, affiliated with CCL-AFL, has won recognition at Toronto. The ILA convention held recently at Chicago has set the pattern which will govern pier operations on U.S. Atlantic coast and Great Lakes ports.

Beginning in 1959, union demands will include a shorter week with no loss of take-home pay; a $100 per month pension plan, equalization of welfare benefits in all union controlled ports, and extra pay for use of bulk loading equipment or any labour saving machinery.

Since seaway cargo will be largely bulk, the penalty clause calling for extra pay may wipe out much of the advantage gained by long-distance shippers.

Canadian Pipeline Projects

Westcoast Transmisson

The main pipeline is proceeding ahead of schedule, and will be completed and tested early in September. Last pipelaying was done early in August and will be cleared and purged from both ends, using purchased U.S. gas for clearing as far north as Savona. Completion of cleaning is scheduled for the second week of September. The Inland system will be cleaned out at the same time.

The west coast gathering system in northern B.C. was ahead of schedule by the end of August. The contractor for the entire system was more than half finished the main 26 inch line from the Baytree area of N.W. Alberta to the West Buick field of B.C. Only 23 miles of ditching and 30 miles of welding remained at the end of July. Laterals were being run by a single spread. Final tie-in from the Alberta side fields was made at the Alaska Highway Crossing on July 24.

Inland Natural Gas

During the last two weeks of June Inland crews had laid 125,000 feet of mains in the interior of B.C. while cleanup was completed between Savona and Kamloops and almost to Grand Forks. By mid-July almost 200 of the total of 304 miles of main pipe had been welded, with backfilling and right of way clearing done for all but the last ten miles.

Distribution systems were completed at Vernon, Oliver, Kamloops and Nelson, and almost 1,000 services installed. The lateral to Salmon Arm was completed to within 2 miles of its goal and yard-coating was 90% done. Pipe for distribution lines was being assembled at Kamloops and reshipped from there. By mid-July crews were moving into the Cariboo area to start on the Quesnel Distribution system. Crews were also at work in the Savona-Kamloops area between Kelowna and Penticton.

First high-pressure test of the transmission system has proved highly successful. A 15 mile section from Kelowna to Oyama held air compressed to 1,056 lbs. per square inch for 24 hours, more than double the minimum pressure at which gas will flow in the system.

Next section to be tested will be between Oyama and Vernon. The air will go as far as Savona and will then be reversed and will be moved back down to the lower end of the system and finally released at Trail. All testing will be completed in September ready for the arrival of gas. Testing was supervised by the B.C. Government Dept. of Railways, which is responsible for final approval of gas pipelines in B.C.

Alberta Gas Trunk Line Co.

Fulton-Bannister Ltd. has a contract for 22 miles of gathering lines in the Provost field. Work consists of wellhead tie-ins, made up of 3 in. to 12 in. diameter pipe. The system will feed gas to the Alberta Trunk Line. Work was also in progress on the Trunk Line main during July from Burstall to Provost. The job consists of 100 miles of 18 inch line from Bindless Jct. to Provost and 17 miles of 34 inch pipe from the junction to Burstall.

Natural gas from three Southeast Alberta fields was released into the Alberta Trunk Line system by Premier Manning on July 23, for testing the AGTL main and the trans-Canada pipeline as far east as Regina. The purpose of the flow was to test and flush the pipe.

Trans-Canada Pipelines

First section of the 34" main Trans-Canada line of Universal Pipe-Lines Limited was due to be welded out late in July and tested by the first week of August while Section 3 of the 34 inch line was nearing completion by late July, the remaining three sections 4, 5, and 6 would not reach completion before mid-August. Work had been retarded on Sections 5 and 6 by heavy rains. On the first section east of Winnipeg, Majestic contractors had started pipelaying on July 1, and by mid-July had completed the first ten miles.

The Miniota crossing of the Assiniboine was completed and the second loop for the 34 inch crossing of the Red River south of Winnipeg was pulled across on June 28. Pipe deliveries were complete on the first section east of Winnipeg. . .

Very heavy rock-work was being encountered by Dutton - Williams Bros. on this section, with rock gangs working on two 10-hour shifts.

On the crown pipeline from the Manitoba Ontario border to Lakehead deliveries of pipe were proceeding and pipelaying had been started on one spread, with starts expected before August on two more spreads and on the fourth by September.

Three major river crossing contracts have been awarded; first across Winnipeg River at Ridout Bay near Kenora, in solid rock, to River Construction Co. (already started); second across Eagle River near Vermillion Bay to Morrison-Shivers, Ltd.; third over the Kaministiquia River near Port Arthur to Houston Contracting Co., which is also a rock crossing. Work on the latter two will start in August.

In Ontario, three contracts had been awarded for the 335 mile $20 million Toronto - Montreal pipeline section of the Trans-Canada for three equal sections. Grayco Inc., Dutton-Williams Bros., and Oklahoma Contracting Co. were successful bidders. The route of the line parallels that of the trans-northern products pipeline fairly closely. There is a substantial amount of rock excavation, though much of the line runs through highly cultivated and settled farm land. No definitely scheduled completion date is set. Welland Tubes Ltd. commenced deliveries of pipe in July.

B.A. Oil Co's recycling plant at Pincher Creek field is now processing 60 million cubic feet of gas daily, extracting 1800 barrels of condensate and 225 long tons of sulphur daily. B.A.'s contract with Trans-Canada calls for 100 million feet of gas daily the first year and 170 million feet after that. Output of extraction plants will be stepped up to 2,500 barrels of condensate and natural gasoline, plus 1,700 gallons each of propane and butane and 275 long tons of sulphur daily. The condensate is of special importance as excellent catalytic reforming stock for use in the manufacture of high octane gasoline.

Regina Distribution System

Gas from the Success field is 'loaned' to Trans-Canada to fill and purge its main line. Trans-Canada will supply gas to Regina for the first heating season. Once the purchase by Saskatchewan Power Corporation of gas from Eastern Alberta fields is authorized by the Alberta Conservation Board, S.P.C. will build the pipeline from the Hatton field to Success, completing the main from the Alberta border to Moose Jaw. Next phase will be extension to Regina. Gas is due to reach Regina August 15. Twelve crews are laying pipe for the S.P.C. distribution system. Seven thousand five hundred services had been signed up by July 1st.

Lakeland Natural Gas

The Ontario Fuel Board has given Lakeland Natural Gas permission to supply gas to the City of Cornwall. Consumers Gas Co. of Toronto had also applied for a certificate but was turned down.

Trans-Canada signed a 20 year contract with Lakeland in July for delivery of more than 12 million cubic feet of gas daily the fifth year of operation. Lakeland serves 17 communities from Port Hope to Morrisburg. Other franchises are being negotiated for other communities including the City of Kingston. Sales to Lakeland the first five years will represent revenue of $6½ million to Trans-Canada the first five years.

Union Gas Company

Union Gas Co. of Canada will start pipelaying in September on the 141 miles of 26 inch gas main from the Dawn field to Hamilton. Canadian Bechtel Ltd. will move one spread from West Coast, section 2 to Galt, Ont., for this work early in August, while their spread from Trans Canada section 6 will move to the Union gas project by mid-August. Pipelaying contracts include lateral lines to London, Strathroy, Guelph, St. Mary's, Kitchener and Hamilton. Gas will also be supplied to Dominion natural gas Co. in Galt. Contract completion date is November 15.

The U.S. Court of Appeals has upheld a F.P.C. order last year permitting Panhandle Eastern Pipeline Co. to make increased sales of gas to Union Gas Co. of Canada. The court's opinion pointed out that increased export to Union would enable Panhandle to employ on off-peak days some of its peakday capacity which would otherwise be idle.

Quebec Natural Gas Corp.

Work was commenced late in July on the Quebec Natural Gas Corp's system in the Montreal area, in preparation for the changeover from manufactured to natural gas, scheduled for December. A start was also made on the main from the 'City Gate' at Trans Canada Pipeline's terminal on the west end of Montreal Island, to connect up with the city's distribution system. An outlay of some $3[illegible] million is involved in these operations. Initially, natural gas will be supplied from storage tanks at Sarnia or from the U.S., through existing pipelines in Southwestern Ontario pending arrival of Alberta gas late in 1958.

Sulphur Prices Weakening

After many years of steady increase in demand for sulphur and rising prices, prices for sulphur fel[illegible] 5% in 1956. Current consumption o[illegible] North American sulphur is some [illegible] million tons annually. It has been announced recently that the Frencl[illegible] gas reserves of 5 trillion cubic fee[illegible] with its heavy sulphur content will b[illegible] fully marketed by 1960. By 1960/6[illegible] France will be supplying the entir[illegible] European demand for sulphur, of [illegible] million tons per year, thus removin[illegible] Europe from world markets.

The outlets for Canadian sulphu[illegible] in export markets is therefore not con[illegible]sidered very bright. This will reduc[illegible] earnings of producers of sour ga[illegible] such as those in northern B.C. field[illegible] supplying Westcoast, and the Pinch[illegible] er Creek Field supplying Trans-Canada Pipelines.

Outlook for Gas Appliance Sales

D. K. Yorath, President of Canadian Western Natural Gas Co., addressing the Canadian Gas Association meeting at Jasper in June, stated natural gas reserves in Alberta alone now stood at 18.3 trillion feet. Population served with natural gas adjacent to main pipelines excluding Alberta totalled 2½ million and prospective customers at 324,000.

In 1956, he stated, there had been 257,000 gas appliance units sold in Canada, which included 43,000 gas warm-air furnaces; 22,000 conversion burners; 26,000 space heaters; 75,000 cooking ranges and 72,600 water heaters. Estimated sales for 1958 would rise 27% to a total of 325,500 gas appliance units, which would include 60,000 gas warm - air furnaces; 30,000 conversion burners; 31,000 space heaters; 93,000 cooking ranges and 90,000 gas water heaters.

Trained Operators May be Scarce

Mr. Yorath warned that the manpower situation over the next several months might become acute for the gas companies. Gas utilities in the United States average one operator to every 140 customers. Applying this ratio to the present potential of 1,275,000 customers in Canada would result in some 9,000 employees. Established companies have a problem, he said, but not as great as new companies serving new territory. The established company at least has a setup where new employees can be trained to handle expansion.

U.S. Gas Industry's Rapid Growth

Encouragement for Canada's gas producers and pipelines is seen in a recent report that the U.S. gas industry, now increasing its list of 3 million customers by almost a million yearly, will spend $2.13 billion on expansion this year compared with $1.55 billion in 1956. The industry is budgeting $8.7 billion for new facilities through 1960. Nearly half the money will go to extending gas transmission facilities. Gas comsumption in states bordering the Pacific is reported to be growing at three times the national average.

Gas Imports Discussed in Congress

In mid-July the argument over imports of Canadian gas to the United States switched from the F.P.C. Hearings to the floor of Congress. Congresswoman Elizabeth Kee of West Virginia told the House . . . "it would be an injustice to our own people to accede to the proposals presently before the Federal Power Commission . . . I have learned that jobs of lignite miners in North Dakota are also at stake in this issue".

There are hints in Washington that should any combination of natural gas companies in the mid-west be given the green light by F.P.C. to import Canadian gas a battle might break out in Congress to prevent the importation of Canadian gas by legislation.

Alberta-California Pipeline Planned

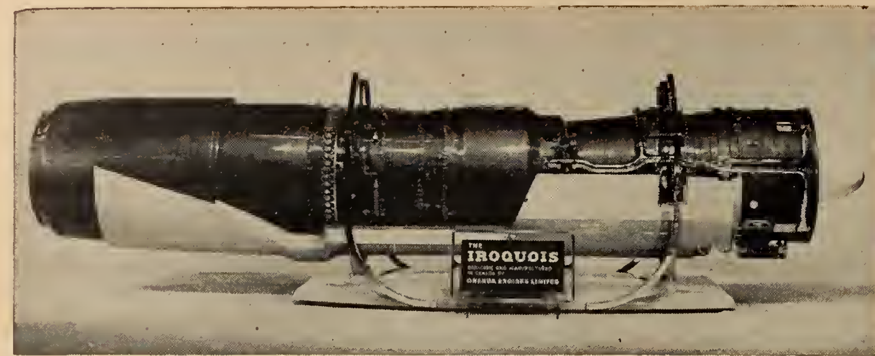
Plans for a third natural gas export line were announced on July 12 by President S. M. Blair of Canadian Bechtel Ltd. This is a $300 million project to link up untapped gas reserves in Western Alberta with central California. The project involves a 36 inch 1300 mile pipeline through the Crows' Nest Pass and through Idaho, Washington, Oregon and Northern California, to terminate in the San Francisco Bay Area. It would supply the Pacific Gas and Electric Co., which would furnish part of the capital. Interested in the project also are Canadian Western Natural Gas Co. and North-western Utilities Ltd.

The system would have an initial capacity of 400 million cubic feet of gas daily. Originating in the Alberta foothills, it would tap some or all of the recent discoveries in the southwestern corner of the province. These include the Savanna Creek, Shell-Waterton, and Texaco-Castle River fields. The southern half of the Pincher Creek field, not yet committed to Trans-Canada, may also be included. Reserves in these fields may total 3 or 4 trillion cubic feet.

Many government approvals have to be hurdled first, however, and doubt is expressed that more than one additional export line from Southern Alberta to the south and west will be approved before a new and careful appraisal of reserves is made by the Alberta Conservation Board.

Application for approval of the project by the Alberta Conservation Board will be made late in August. The program would enable Alberta producers to sell gas direct to the large and growing California market without any build-up period.

A ripening field of wheat in Central Manitoba provides a rural setting for the construction this season on the western section of the Trans-Canada Pipe Lines natural gas line from Alberta to Eastern Canada. Here the bending machine on section six bends an 80-ft. double joint of 34-inch diameter pipe to fit the contours of the ditch. The pipe line obtains a sixty-five foot right-of-way from the farmers, and men and equipment work in that area, thus crops such as this one are left undamaged.



The Iroquois on Show

The world's most powerful jet engine, Orenda Engines Ltd.'s 'Iroquois', was unveiled at Malton July 22nd by Defence Minister George R. Pearkes, V.C. With unveiling came the news that a U.S. engine manufacturer, believed to be the Aeronautical Division of the Curtiss-Wright Corporation, is negotiating for licensing rights to build the engine. Britain is said to be watching the Iroquois with unusual interest, and some day it may be produced there.

Designed for Canada's top - secret twin engine supersonic interceptor the CF-105, the 'Iroquois' has a thrust rating of over 20,000 lb. more than triple that of the 'Orenda' engine which powers the CF-100. The power potential of the basic Iroquois design is such that later versions will provide more thrust than any other engine in the same stage of development.

Its size is approximately twice that of the Orenda 14. Power-to-weight ratio is better than 5 to 1, compared with the 3 to 1 ratio of the Orenda 14. This was achieved through the use of titanium. Weight is less per pound of thrust than that of any other large supersonic engine known to be running to date.

Avro's 17-ton CF-100, now in service ascends up to 8 or 9 miles in about 7 or 8 minutes with its Orenda 14 power plant.

The Iroquois powered 'Arrow', CF-105 weighing twice as much, will reach altitudes four or five miles higher in about half the time; a rate of climb over 15,000 f.p.m. Once there it will fly at better than twice the speed of which the CF-100 is capable.

Of the more than 2,100 firms supplying Orenda with materials, components and services, the vast majority were Canadian, though the company had received much appreciated assistance from U.S. and United Kingdom firms. The 'Iroquois' model was displayed late in July 1957 at the Air Power Panorama in Washington. It will also be shown at the SBAC static display at Farnborough in Britain in September.

Other highlights of Iroquois performance in flight are:

Ten Iroquois engines could develop as much power as the Sir Adam Beck power station at Niagara Falls, Ont., yet the Iroquois weighs no more than a modern luxury automobile.

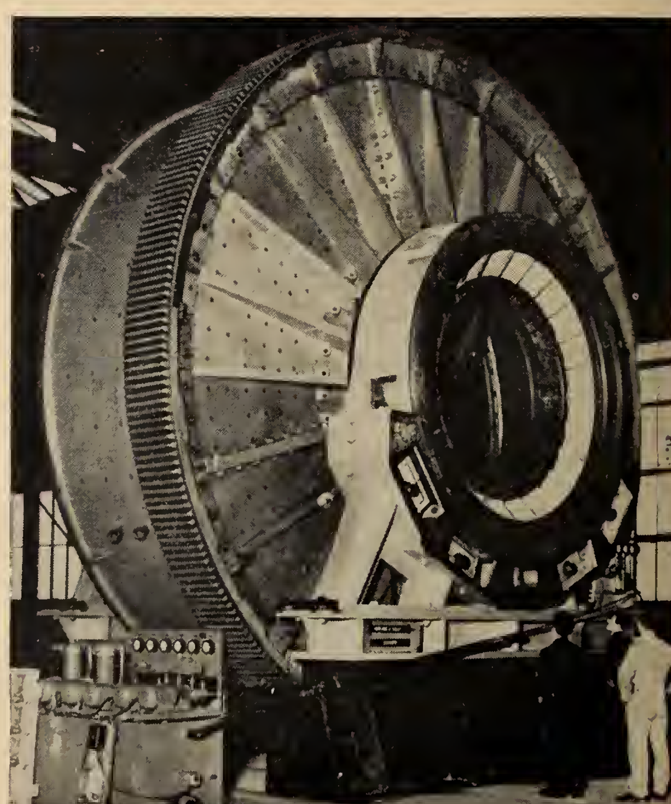
The air swallowed and exhausted by one Iroquois is more than could be supplied by 2,500 portable compressors of the type used in the construction industry.

In spite of the Iroquois' tremendous power — over 100,000 horsepower, the engine consumes only 10 times more oil than the ordinary automobile engine of, say, 200 horsepower.

Since fitting the 'Iroquois' test-pod to an experimental B-47 bomber by Canadair Limited at Montreal last spring, the engine is being test-flown in the pod for eighteen months or more before installation in some supersonic test bed and finally in the CF-105. Following two years of test-cell running, the flying tests of the Iroquois mark an important stage in development.

CANADIAN DESIGNED 20-TON GEAR

This 308-tooth gear, believed to be one of the largest designed in North America, was designed by Aerofall Mills, Ltd., of Toronto and the order placed with David Brown (Canada) Limited. Casting and cutting were done in the Manchester, England, works of David Brown Ltd. Shipped in sections to Glasgow, Scotland, the gear was assembled in the works of Harland and Wolff, before shipping to Sinoia, Southern Rhodesia, the site of the Mangula Ltd. copper mine. The gear weighs 41,000 lb. Its pitch diameter is 25 ft. 8 in. and the width of the face is 20 in. The 308 teeth mesh with a 29-tooth pinion which gives the drive a pitch line velocity of 975 ft. per min. It transmits 1250 h.p. with a mill speed of 14.1 r.p.m. The mill in which this gear is used has a capacity of from 100 to 200 tons per hour and was to be in operation in July 1957.



Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE
ELECTIONS AND TRANSFERS

A Bequest to the Institute

Recently through the Crown Trust Company of Montreal the Institute has received the sum of $25,000 from the estate of the late Major James H. Brace who for thirty-nine years was a member of the Institute. The donor in his will specified that the interest on the fund shall be used for the benefit of unemployed and needy engineers.

This is by far the largest benefaction that the Institute has received, and beyond a doubt will do much good in the field that has been selected by the donor. In times like these not many engineers are in want but conditions may change so that the fund will become of vital importance. Even now the Institute is aware of cases where the money can be used to good purpose.

Major Brace was born and received his education in the United States, graduating in civil engineering from the University of Wisconsin in 1892. For the next eleven years, he worked mainly on waterways and power projects in the Great Lakes and Upper St. Lawrence areas.

After moving to New York City in 1903, he worked for a consulting engineer on the construction of railway tunnels under the East River. It was on this project that he first became associated with Charles E. Fraser, M.E.I.C., with whom he formed a partnership in 1908 to found the construction firm of Fraser, Brace and Company.

This was the beginning of nearly a half century of activity during which as vice-president, he directed the construction activities of the company in both Canada and the United States. In addition to the construction of large hydro-electric projects, Major Brace directed the constuction of some of the largest chemical and metallurgical plants built in Canada.

His contributions to the war effort of both world wars were significant. During the first years of World War I, he supervised construction of a hydro-electric project in Quebec, needed for the province's industrial contribution to the war effort. In 1917, he joined the United States Army as a Major in the U.S. Engineers Corps and served with them in France. In World War II, he came out of semi-retirement at the age of seventy-five to contribute unsparingly of his time and energy to supervision of construction projects in Canada and the United States. These included ordnance plants in both countries and the first Canadian Atomic Energy plant at Chalk River. He was also concerned with the construction and operation of one of the largest shipyards in Canada.

Following the retirement of his original partner in 1946, Major Brace became president of Fraser-Brace and guided the affairs of the company during the following eight years.

He joined the Engineering Institute as a member in 1916, was elected to Life Membership in 1947, and continued to take an interest in its affairs until his death in April, 1956, at Westmount, Quebec.

Cover Picture

An example of recent growth in the Canadian oil industry is the recently rebuilt refinery of Imperial Oil Company, at Halifax, N.S. A $30-million construction program increased capacity from 18,000 to 42,000 barrels daily. In the picture, atmospheric and vacuum distillation unit is shown at left; fluid catalytic cracker at centre; and light ends plant at right.
(Imperial Oil Photo)

Publicity

Members will be interested to know that the newspapers of Canada found the program of the 1957 annual meeting of sufficient interest to devote an unusual amount of space to reporting on it.

From a press clipping service, the Institute has gathered together clippings from a great many papers from coast to coast. These clippings have

WANTED

FIELD SECRETARY

The Institute is seeking applications for the position of Field Secretary, working out of the Toronto office. Position involves travel, public speaking, organization work and administration. Membership in the Institute is not essential, but preference will be given to Members.

Apply in writing to

L. F. GRANT,
2050 Mansfield St.,
Montreal 2, Que.

been sorted, measured, collated and studied.

The results show that the newspapers have done an excellent job of reporting. About 500 separate news items were published in the newspapers of sixty-seven cities. On an overall space basis the clippings are the equivalent of over twenty-five full newspaper pages—and that is a lot of space.

This is a new record for the Institute, and in all probability compares favourably with the record of any other similar event in Canada. When it is remembered that the meeting occupied only three days, it will be appreciated that the Engineering Institute of Canada must have been very prominent before the Canadian people in the daily press.

This splendid showing indicates again the national character of the profession and the Institute. Papers all the way from Vancouver Island to Newfoundland found news of the Institute's activities to be of interest to their readers.

Members everywhere will be pleased to learn that the things that interest them so deeply also interest the general public.

IAESTE Report, 1957

The season is now well enough advanced to present a picture of this year's results of our participation in IAESTE (International Association for the Exchange of Students for Technical Experience). It has been the fifth year of Canadian activity under this plan, and during this time as most readers are aware; the Institute has acted as the agency for handling the work in this country.

From the point of view of the European students coming to Canada for employment, 1957 has once more shown a good step forward in participation figures. Our industries and other engineering organizations were hosts this summer to 119 foreign students, from 9 countries, again representing nearly all branches of engineering. This figure can be compared with 89 in 1956. As might be expected the majority always come to us from Great Britain, and 76 of the 1957 visitors originated from there. The jobs in Canada for all of these young engineers were provided through the excellent co-operation of 51 firms, public departments, and other organizations. The names of these firms appear in the annual report, printed by the international headquarters of IAESTE in Sweden.

The story as it concerns Canadian undergraduates going abroad under the plan is not so impressive. Only 12 took advantage of the exchange opportunity this year, as compared with 9 last year. One might say that this is a 33 percent increase, but still the figure is very small. Judging from the number of preliminary inquiries, and what happened to them afterward, the reason for such scant interest in the plan by Canadian students remains the same — the difficulty of financing the trip on the estimated earnings at European wages.

This Canadian participation of only 12 is in spite of the fact that travelling bursaries of $250, provided by our industry, were available to each Canadian student, and this was well publicized at our universities. It was hoped, and expected, that this added new inducement would promote a much larger exodus in the eastward direction this year, but the results have been disappointing. This might indicate taking a second look at the policy of continuing these bursaries, and this will be something for the Canadian IAESTE Committee to consider.

In connection with the exchange program, Eastern Canada again had the pleasure of a visit in July by Mr. James Newby, who is continuing to act as the IAESTE secretary for Great Britain. He visited a large number of firms and other organizations to promote interest in the plan. The illustration shows a party of 43 engineering students from Great Britain arriving in Montreal with Mr. Newby on the *Ivernia*, bound for various points in Canada.

Full information concerning IAESTE, and Canadian participation in it, can be obtained at any time from E.I.C. headquarters, Montreal.

Ottawa Regional Meeting

There will be a regional meeting of the Engineering Institute of Canada

to coincide with

the semi-centennial celebrations of

the Ottawa Branch

October, 1959

Further announcements will appear as plans take shape.

Modern Management of an Institute

For quite a time the Council of the Institute has been facing the challenge of changing times. Recently some action has been initiated that should enable the Institute to evolve a program that will bring policy into alignment with new opportunity.

There appears to be no doubt but that the old patterns will not do for the future. Even the branches are feeling, or will feel, the demand of changing conditions, but most of all it will be the Institute that will come forward with new ideas.

To this end Council has appointed recently several new committees to study conditions and to make recommendations and to carry out those proposals that are approved by Council. These committees are as follows:

(1) Policy Committee. A host of proposals have been made by individuals, branches and officers as to new business for the Institute and changes in policy regarding old business. To handle these urgent matters Council has appointed a Policy Committee whose personnel is as follows:

R. L. Dunsmore, Montreal, *Chairman;* B. G. Ballard, Ottawa; R. L. Hearn, Toronto; R. E. Heartz, Montreal; I. P. Macnab, Halifax; D. M. Stephens, Winnipeg; . B. Stirling, Montreal; W. G. Swan, Vancouver; I. R. Tait, Montreal; V. A. McKillop, President; C. M. Anson, President-Elect; K. F. Tupper, Toronto; L. Austin Wright, General Secretary.

(2) Technical Activities. This committee is to organize committees on a national basis that will develop a more intensive program of technical papers and meetings. May of these committees are already functioning and it is expected their influence will be felt before the end of the year. The personnel of the committee is as follows:

F. L. Lawton	Montreal — *Chairman*
B. G. Ballard	Ottawa
C. E. Frost	Montreal
R. M. Hardy	Edmonton
A. R. Harrington	Halifax
W. H. Paterson	Toronto
D. L. Rigsby	Kingston
S. Sillitoe	Belleville
E. R. Smallhorn	Montreal

(3) Property Committee. For many years consideration has been given to the Institute's property at 2050 Mansfield Street, Montreal. The time has come when it is necessary to decide what should be done about it. Should the present premises be enlarged or should a new site be found? The present building is quite inadequate for present conditions and it is evident more space will have to be found to meet the steady expansion of the Institute and its activities. To advise Council the following committee has been formed.

F. G. Rutley	Montreal, *Chairman*
Albert Deschamps	Montreal
V. B. King	Woodstock, Ontario
C. N. Murray	Sydney, N.S.
R. C. Pybus	Vancouver

(4) Student Policy Committee. The changing picture surely includes the field of service to the engineering student. Some quite revolutionary proposals have been made and it is to study these and other ideas of their own that this committee has been authorized. The members are:

C. G. Southmayd, *Chairman*

Professor Julien Dubuc, EIC Faculty Representative at Ecole Polytechnique.

Dr. R. E. Jamieson, McGill University.

Dr. Andrejs Pakalnins, EIC Faculty Representative at McGill.

E. Muszynski (McGill) and Jean F. Riel (Ecole), Student Representatives ... Junior Section of Montreal Branch EIC.

(5) Education Committee. This committee has not yet been authorized but it has been recommended by the Education Conference held during the annual meeting at Banff, and the indications are that Council will approve the proposal.

For two years the Institute has sponsored an education conference organized by and for the educators themselves. These two conferences have been most successful and it is believed the deliberations will have a far-reaching and beneficial effect on engineering education in Canada.

It seems appropriate that the Institute should now establish its own committee which for the future can keep the needs of education before the Institute and provide the educators a channel between themselves and the Council of the Institute.

This recommendation of the Conference along with five others made by them will be presented to Council for decision at the August meeting.

It is doubtful if ever in the past the Institute has planned so much study of itself. It is a good sign. It is evidence of Council's awareness of what is going on and of its obligations to the profession.

Some of the 119 foreign students from nine countries representing all branches of engineering who came to Canada this year as participants in the International Association for the Exchange of Students for Technical Experience.

The Annual Meeting

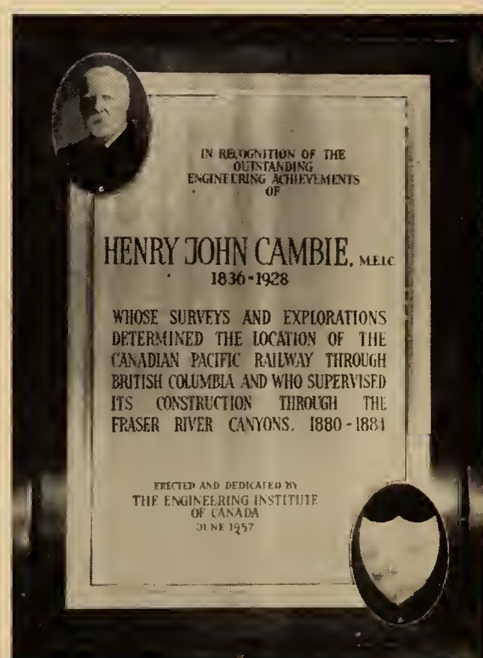
I. R. Tait (standing) is addressing the annual business meeting of the Institute. With him at the head table are treasurer R. A. Emerson, R. L. Dunsmore, president V. A. McKillop, L. Austin Wright and Miss May McLaren.

Below. The General Secretary received a gift of the ten gallon hat he is wearing from the Alberta committee. In this picture Carl Jones, immediate past-chairman of the Calgary Branch is making the presentation to Dr. Wright.

Student delegates at the annual meeting student conference are shown below. Not in order of their appearance they are: A Clark and N. Crawford of the University of Alberta; N. M. Seagram, University of Toronto; O. M. Hodgkins, Royal Military College; R. Hutchinson, University of Alberta; S. Saimoto, University of British Columia; E. J. Muszynski, McGill University; J. N. Fry, University of Alberta; J. F. Harris, chairman and moderator of the conference; L. D. Lemay, Ottawa University, secretary of the conference; J. F. Riel, Ecole Polytechnique, chairman of the conference; M. C. Schofield, University of New Brunswick; R. Barschel, University of Manitoba; J. D. Devlin, Nova Scotia Technical College; M. Chamberland, Laval University; J. B. Robinson, Western University; D. Meneley, University of Saskatchewan, and W. Sexsmith, of Queen's University.

ANNUAL BANQUET HEAD TABLE GUESTS

Left to right, reading down are: W. A. Smith, chairman, annual meeting committee; C. A. Peachey, president, C.P.E.Q.; Mrs. W. A. Capelle; W. O. Richmond, president, A.P.E. of B.C.; Mrs. W. G. McKay; Group-Captain C. L. Ingles, R.C.A.F.; Mrs. O. J. Walker; F. G. Rutley, representing the president, Canadian Chamber of Commerce; Mrs H. L. Bouey; E. J. Durnin, past-president, Dominion Council; Mrs. J. H. Fox; Commodore E. R. Spencer, R.C.N.; Mrs. C. M. Anson; P. M. Sauder, Hon. Mem. and past-vice-president, E.I.C.; Mrs. A. G. L. McNaughton; W. S. Wilson, Hon. Mem. and past vice-president, E.I.C.; Mrs. M. S. Coover; M. G. Lockwood, president, A.S.C.E.; Mrs V. A. McKillop; Hon. S. Freedman, Judge of the Court of Queen's Bench, Manitoba; President V. A. McKillop; Mrs. S. Freedman; T. A. Crowe, past-president, I.M.E.; Mrs. W. S. Wilson; M. S. Coover, president, A.I.E.E.; Mrs. W. O. Richmond; General A. G. L. McNaughton, Hon. Mem. E.I.C., and chairman, Canadian Section, International Joint Commission; Mrs. M. G. Lockwood; J. G. Frost; president, Association of Consulting Engineers of Canada; Mrs. E. J. Durnin; O. J. Walker, president, C.I.C.; Colonel W. A. Capelle, Canadian Army; J. H. Fox, president, A.P.E. of Ontario; Mrs. P. M. Sauder; H. L. Bouey, representing the president, The Royal Architectural Institute of Canada; Mrs. J. G. Frost; W. G. McKay, president of A.P.E. Saskatchewan; Mrs. W. A. Smith; and C. M. Anson, president-elect, E.I.C.



CAMBIE MEMORIAL

Retiring President V. A. McKillop (left) unveils the Henry J. Cambie memorial plaque. This plaque offered by the E.I.C. in memory of a great pioneer engineer will be placed in the C.P.R. station, Vancouver. With the president is R. L. Dunsmore, Montreal. A close-up of the plaque is shown above.

The President Reports

PROGRESS AND PLANS

V. A. McKillop, M.E.I.C.
London, Ontario

The retiring president at Montreal last year, Dr. R. E. Heartz, included in his fine remarks, particular reference to three matters that should receive the attention of the Institute in the future. These were, Confederation, Technical Sections and Honours.

Progress has been made on all three of these subjects, although much remains to be done.

Confederation

We have discussed Confederation at branch meetings throughout the year, and there is no need at this time to do more than reaffirm the active interest of the Institute as expressed at the annual meeting a year ago. You are aware that during this past year the matter has been under review by the provincial associations, and that their reports have recently been received by Dominion Council. Now that those reports have been received and acted upon by Dominion Council, it will be necessary to bring the representatives of the Institute and Dominion Council together to further the study of a satisfactory basis for a union between the Institute and Provincial bodies. I sincerely hope that there may be no delay in taking action so that the interest and enthusiasm aroused in the membership during recent years may not lag, but be kept alive by evidence of continued progress toward a mutually satisfactory arrangement.

Technical Sections

The second recommendation in last year's presidential address, that of technical sections, will I assure you be definitely in the class of progress and accomplishment during 1957.

You will recall that this matter arose as the result of a report by the Committee on Technical Operations under the chairmanship of F. L. Lawton. That report stated that "now as never before there is a real need to undertake constructive work to improve the technical activities of the Institute in order to achieve, on the scale necessary, our basic objectives, which are "to facilitate the acquirement and interchange of professional knowledge among its members, to promote their professional interest, to encourage original research, to develop and maintain high standards in the engineering profession, and to enhance the usefulness of the profession to the public".

It is anticipated that Headquarters will be able to actively proceed with the recommendations of this report within the next three months.

Awarding of Honours

The third recommendation last year concerned the awarding of honours to engineers. You will realize that the unveiling of a plaque at this convention, for erection in the Vancouver station of the Canadian Pacific Railway in honour of Mr. H. J. Cambie, is another step in this direction. The publication of biographies, one of which is on sale here, represents achievements in the same field.

Now I would like to speak to you about a variety of matters that I consider of importance to the Institute, all of which might very well be covered by a text extracted from a statistical record of the Institute compiled by Huet Massue, a member of the Montreal Branch. Within the covers of that fine review will be found this statement, "enlightened membership is the life blood of any association; it is the foundation from which arose the monument of its accomplishments; it is the beacon from which radiates its initiative, its enterprise and its inspiration. The broader the foundation the more imposing the monument; the higher the beacon the farther afield its projection." I have a very strong feeling that that statement is most important at this time, in fact, the prime purpose of many activities and proposals before Council in recent months is the enlightenment of the membership. I think it is well that we remember that in all the field of important activities of the Institute, nothing can be more important than the dissemination of information which will in turn lead, I trust, to a more active participation in the affairs of the Institute by individual members, and a greater realization of the vital part that this organization plays in the affairs of this country.

In discussing the enlightenment of the membership the work of the Publications Committee, under Chairman G. N. Martin, naturally comes to mind first. Council has accepted a report from this committee that will result in the publication of Transactions this year. It seems very appropriate that this project should begin when the recommendations of the committee on technical operations are about to be implemented. Each can contribute to the success of the other. Likewise, there will be published a book entitled "Canadian Careers in Engineering". This will deal with the engineering work in various types of industry, and has already attracted widespread interest from employers of engineers.

Policy Committee Proposals

The appointment of a Policy Committee composed of past presidents, and men who have long taken a leading part in Institute affairs, led to the discussion of various proposals. One of the most important of these concerned the extension of the work of the Field Secretary's office. This was a well deserved recognition of the excellent work of past president Col Grant, whose name is closely associ ated with the Professional Develop ment courses that form an importan part of the activities in many branches.

The recommendation of the Polic Committee has led to the recent ap pointment of a second field secre tary, Commodore Davy of Vancou ver. His responsibility will be th four Western Provinces. Another rec ommendation of this committee ha led to the appointment of an Institut representative on the campus of te universities. It is anticipated th more will be appointed and wi make the Institute well known to th students, leading to many studen memberships and arousing an intere in the young engineer that is like to remain with him.

Regional meetings have been discussed frequently in recent months, and this idea has come to the fore for a variety of reasons. One of these in recognition of the difficulties being experienced by some branches to provide programs of a calibre to attract a major portion of the membership. It has been determined that this same condition applies today in many organizations, and it is believed that it calls for changing plans to meet changing conditions.

Regional Meetings Suggested

Since technical sections are about to be promoted, and since annual meetings have become so large that they have taxed the capacity of the larger hotels it is a possibility that such regional meetings might provide an opportunity for technical discussions, without the complications arising from heavy registrations. Such a meeting would probably provide new opportunities for individual participation, and for consideration of public problems peculiar to a certain area. Whereas individual branches might have difficulty in attracting the better class of speaker, it should be quite practical to bring such a man to regional meetings. It is apparent that many branches would appreciate assistance in securing speakers; these meetings would at least provide a partial solution for this problem. There are several reasons to assume that regional meetings could fill a real need.

The Institute has made a great contribution, and will continue to assist in the technical problems that face us today. It is recognized that the required quantity of engineers and technicians is being emphasized and much has been done to provide more facilities, more staff and to secure more students. The Institute is also conscious of the need for quality as well as quantity in our plans, and for all these reasons has again at this annual meeting invited the Deans and heads of departments from engineering schools to assemble here, to continue discussions begun one year ago.

The professional development courses, to which reference previously has been made, constitute an attempt to broaden the interest and the knowledge of the young engineer. Thus professional attitudes develop and recognition will follow. We believe that such a development is the natural outcome of membership in a voluntary organization, and must ultimately lead to the characteristics so necessary and desirable in a professional man.

The formation of a Property Committee this year, under the Chairmanship of F. G. Rutley, is intended as recognition of the long term growth of the Institute, including the possibilities of Confederation. This committee has membership representing various parts of the country, from coast to coast, so that its report, when complete, may really reflect the ideas of all parts of this country in the creation of a new National Headquarters. It is not suggested that there is any great urgency in this regard, although property values should be considered in relation to the rate at which building reserves are being accumulated.

International Geophysical Year

At this point I want to refer to the International Geophysical Year which commenced July 1, 1957. It had been hoped that at least one paper dealing with this matter might be on our program at this Convention. It was found that that would not be practical because of the many preparations going forward at this moment. It is a matter of pride to the Engineering Institute of Canada that Canadian scientists are, of course, taking a large part in the program of study and research. I am sure that we will follow the progress of our scientists with very real interest. They have our sincere wishes for a successful conclusion to their efforts.

In conclusion I would just like to repeat that I feel this Institute should concentrate on any and every project that will make for a more enlightened membership. I believe that knowledge of the many activities of the Institute will make it a more vital influence in the life of its members. I believe that individual participation in projects of community and national importance might be expected to increase with understanding of the Institute's program. I would hesitate to make any specific recommendations for new projects because I believe that we should only participate where we can make a real contribution. Nevertheless, I might remind you that the Engineers Joint Council in the United States has for sometime had a very active committee to consider a national water policy. Here is the kind of project that concerns every person in every community in the whole country, and will undoubtedly continue and increase in importance. In this connection, I wish to quote our own member, Robert F. Legget of Ottawa, who delivered the sixth Wallberg lecture in 1953. His topic was "Resources for Tomorrow — the Engineer's Stewardship". In it he makes this observation. "Since it is the engineer who is responsible, not only for processing the materials which we have been discussing, but also for the ever-increasing speed at which they are being used up on this continent, admittedly in response to public demand, is it not incumbent upon him to take at least a general interest in the resources of which he is the steward?"

Another matter of country wide importance is the announcement of the policy of labour leaders to press for a shorter work week. Such a trend may well be of considerable importance to the engineering profession. Since the reduction in hours of work to date, coupled with a remarkable improvement in the standard of living, has been possible because mechanical power has increased the output capacity of the individual worker; it would seem that the labourer needs the engineer if his dream of more leisure is to come true. It would seem to me that the matter of land use and town planning might very well provide opportunities for worthwhile contributions both by the individual engineer and the Institute.

Tribute Paid

I would not want to conclude my remarks here without paying a tribute to the officers and staff of the Institute, who by their vision and work during the years have placed this Institute in a most enviable position, nationally and internationally. In particular, I would like to pay tribute to the General Secretary with whom it has been a very real pleasure to work during this past year. His contribution to the growth of the Institute is probably more than most of us realize, and I am sure that in time his achievements will receive proper recognition. I trust that some day soon he will get busy on his memoirs in the form of a history of the Institute. I would like to see it made clear to him that such an effort on his part would be most welcome.

In this tribute, I wish to include Mrs. Wright. To know her is to realize that she possesses many of the characteristics essential to the growth of this organization, and I am confident that her inspiration has contributed greatly to our success.

International Cooperation

THE warm friendship which exists between the Dominion of Canada and the United States of America is known, admired—and perhaps sometimes envied—throughout the civilized world. There is nothing like it anywhere else on earth. There never has been a friendship so genuine, a mutual understanding so sincere, that the imaginary line which serves as your southern border and as our northern border, has little real significance—except political. The border between our countries is a useful instrumentality for separating jurisdictions; for marking the points where the color of uniforms change, but where the character of men do not.

We should, and unquestionably will, preserve integrity of the border between us. For it affords a good exercise in geography for your children and ours, as they study the rich and peaceful history of these enviable relations.

All this long friendliness, this mutual confidence and respect, has led to the very remarkable situation that in many instances your magnificent Queen is our Queen, our President—your President. Indeed it is even deeper than that: your triumphs are our triumphs; our sorrows—your sorrows.

This is all quite well known. Not so well known, though, except among engineers, is the fact that this unique spirit reaches perfection in the relationship between Canadian and American engineers. And between your Institute and our Founder Societies.

As you know, I have the honour here to represent the American Society of Civil Engineers. In its behalf, I am moved to express deep and abiding gratitude to the Institute for its part in welding an iron ring around these good relations, to the end that they shall always prevail among us.

Finally I salute you for your noble achievements of the past and confidently predict a future of extraordinary usefulness in helping your youthful, virile and robust country to achieve its incredibly promising destiny.

M. G. LOCKWOOD,
President,
AMERICAN SOCIETY OF CIVIL ENGINEERS

Part of an address of greeting to the annual meeting of The Engineering Institute of Canada, Banff, June, 1957.

PROPOSED CO-OPERATIVE AGREEMENT

between

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF PRINCE EDWARD ISLAND

and

THE ENGINEERING INSTITUTE OF CANADA

MEMORANDUM OF AGREEMENT made in duplicate at the City of Charlottetown in the Province of Prince Edward Island, this Twenty-fifth day of September, 1957

By and Between:

THE ENGINEERING INSTITUTE OF CANADA having its head office at the City of Montreal, in the Province of Quebec, hereinacting by its President and General Secretary, duly authorized for the purpose hereof by a resolution of its Council passed at a meeting duly called and held on the twenty-third day of August, 1957 hereinafter called the "Institute";

PARTY OF THE FIRST PART

and

THE ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF PRINCE EDWARD ISLAND, having its head office in the City of Charlottetown, in the Province of Prince Edward Island, hereinacting by its President and Registrar duly authorized for the purpose hereof by a resolution of its council passed at a meeting duly called and held on the ....day of ....1957, hereinafter called "The Association"

PARTY OF THE SECOND PART

WHEREAS it is desirable in the interests of the Engineering Profession that there be close co-operation between the Institute and the Association, and

WHEREAS such close co-operation will be promoted if, so far as is practicable, there is effected:

(a) A common membership in the Province of Prince Edward Island of the Institute and the Association.

(b) A simplification of existing arrangements for the collection of fees.

(c) A co-ordinated management.

NOW, THEREFORE, the parties hereto agree with each other as follows:

Sec. 1: Any person resident in the Province of Prince Edward Island who, on the date of this agreement is registered as a Professional Engineer in the Association and is not a Corporate Member of the Institute, shall have the right, under the provisions of this Agreement, to become a Corporate Member of the Institute. If such registered Professional Engineer desires to become a Corporate Member of the Institute under the conditions of this agreement, he shall so notify the Registrar of the Association, in writing, within 12 months of the date of this Agreement.

Sec. 2: Any person resident in the Province of Prince Edward Island registering as a Professional Engineer in the Association subsequent to the date of this Agreement who is not a member of the Institute shall, have, upon such registration, the right to be accorded the class of membership in the Institute warranted by the age, experience and professional qualifications of such person, according to the by-laws of the Institute and the decision of the Council of the Institute. If such Registered Professional Engineer desires to secure membership in the Institute under the conditions of this Agreement, he shall so notify the Registrar of the Association in writing, within 12 months of the date of such registration.

Sec. 3: Registered Members of the Association shall not be required to pay the transfer fees of the Institute. Registered members of the Association shall not be required to pay the entrance fees of the Institute, provided they make application in accordance with Sections 1 or 2.

Sec. 4: Any Corporate Member of the Institute who is, at the date of this Agreement, or who thereafter becomes, a resident of the Province of Prince Edward Island shall be eligible for membership in the Association if qualified for such membership, and all entrance fees otherwise payable to the Association shall be remitted provided that application for membership in the Association is made within twelve months of—

(*a*) The date of this Agreement in the case of any Corporate Member of the Institute who is at such date a resident of the Province of Prince Edward Island; or

(*b*) The date on which he becomes a bona fide resident of the Province of Prince Edward Island in the case of any Corporate Member who is not at the date of this Agreement such a resident;

Sec. 5: Any person who subsequent to the date of this Agreement becomes a member of the Institute, or advances his grade of membership therein and who is or becomes a resident of the Province of Prince Edward Island, shall be eligible for membership in the Association if qualified for such membership, and entrance fees otherwise payable to the Association shall be remitted up to the amount of the entrance fee currently required for the grade of Institute membership held, provided that the application for membership in the Association is made within twelve months of the date on which he becomes a member of the Institute or advances his grade of membership therein.

Sec. 6: Notwithstanding the provisions for the total or partial remission of entrance fees in sections 3, 4 and 5 hereof, if subsequent to the date of this Agreement either or both parties hereto change the amount of the entrance fee required, then provision shall be made for the total or partial remission of entrance fees to continue the intention of this Agreement, namely, that when a resident of the Province, of Prince Edward Island who is a non-member of both the Institute and the Association, but who becomes a joint member within a 12 months period, shall be required to pay in entrance fees a total amount not greater than the larger of the two individual entrance fees.

Sec. 7: (1) in lieu of the ordinary membership fees of the Institute the following annual fees are hereby established for members of the Association who at the same time are, or who may become members of the Institute.

(*a*(Members per annum	$14.00
(*b*) Juniors per annum	8.00

(2) The annual fee payable to the Institute by Members of the Association who are, or who may become members of the Institute shall be due and payable on the First day of January in each year, and shall be paid to the Association on behalf of the Institute.

(3) Each member of the Association who pays such annual fee to the Institute through the Association shall be entitled to all the privileges of Membership in the Institute, and to the annual subscription of the Institute Journal.

(4) The Association undertakes to receive the appropriate annual fee for membership in the Institute from each of its members who pay the same, and to remit the amount collected to the Institute at its Head Office at least once a month.

(5) The provisions of this section of this Agreement shall become effective on the First day of..................... 19......

Sec. 8: On the First day of January of each year the General Secretary of the Institute shall furnish to the Registrar of the Association a list of members of the Institute resident in the Province of Prince Edward Island, indicating as far as possible those who are not members of the Association. On the same date the Registrar of the Association shall furnish the General Secretary of the Institute with a list of members of the Association in good standing as on the thirty-first day of December preceding, indicating as far as possible those who are members of the Institute under the terms of this Agreement.

Sec. 9: It is agreed that the Branch of the Institute in Prince Edward Island shall continue to function actively as such during the term of this Agreement and to enable such functioning there shall be set up and continued from year to year during the term hereof a Committee of five members, all of whom shall be members of both the Association and the Institute, to be known as the Joint Finance Committee; two of said members shall be appointed annually by the Council of the Institute; two members shall be appointed annually by the Council of the Association, and the fifth member who shall be a corporate member of the Institute and a registered professional engineer, shall be appointed annually by the four members aforesaid and the fifth member shall be Chairman of the Committee. In case the four members aforesaid fail to appoint the fifth member within thirty days from date of their appointment, the said fifth member shall be appointed by the President of The Engineering Institute of Canada within a further period of thirty days. The said Committee shall recommend to Council of the Association, annually, the sums of money to be paid by the Association to the Branches of the Institute for their operation and such sums to be paid by said Council shall not be less than the per capita amounts now paid by the Institute provided, however, that such payments are made from annual revenue and in no case from capital reserve.

Sec. 10: During the term of this agreement the officers and the Council of the Association shall ipso facto be and become the officers and the members of the Executive Committee of the Prince Edward Island branch of the Institude. Any Prince Edward Island member of the Institute elected president or vice-president or councillor of the Institute shall be an ex-officio member of this Executive Committee. The Executive Committee as so constituted will be responsible for the management of the Prince Edward Island Branch.

Sec. 11: The representative upon the Council of the Institute of the members of the Institute in Prince Edward Island will be nominated and elected in accordance with by-laws of the Institute.

Sec. 12: Each year, the Institute shall pay to the Prince Edward Island Branch the regular Branch rebate of fees in accordance with the by-laws of the Institute for each member of the Institute resident in the Province of Prince Edward Island who is not a member of the Association.

Sec. 13: Each meeting of the Prince Edward Island Branch of the Institute and the Association will be announced as a joint meeting thereof with the exception of any legally required special or annual meetings of either the Prince Edward Island Branch of the Institute or of the Association.

Sec. 14: Upon the occasion of any of the following, the other party to this Agreement shall be so informed within a period of one month, in writing:

(a) the acceptance of the resignation of a joint member by one party to this Agreement, or;

(*b*) the removal from the membership roll or from the register, of the name of a joint member by one party to this Agreement, or;

(*c*) the receipt by one party to this Agreement of notification from a joint member that he has taken up permanent residence outside the Province of Prince Edward Island.

Sec. 15: The term of this Agreement shall be for a period of three years commencing on the first day of January 1957 and ending on the 31st day of December 1959 on which date this Agreement shall terminate provided either party has given to the other notice of termination at least six months prior to the 31st day of December 1959 and if no such notice is given this Agreement shall continue after 31st day of December from year to year but may be terminated at the end of any calendar year by either party giving notice in writing to the other of such termination at least six months prior to the end of the calendar year. Notice of termination of this Agreement shall be given by the delivery by one party to the other of a certified copy of a resolution of the Council of the one party to that effect.

Sec. 16: The terms and conditions of this Agreement may be amended by mutual agreement in writing between the Councils of the parties hereto duly executed by their accredited officers.

Sec. 17: This Agreement and the terms and provisions thereof shall not be applicable to the Institute members who are not, and do not become, registered with the Association. Likewise, this Agreement and the terms and provisions thereof shall not be applicable to Registered Professional Engineers of the Association who are not, and do not become, members of the Institute.

Sec. 18: Nothing in this Agreement shall prevent either party thereto from exercising its rights and privileges with respect to the disciplining, the suspension, or the expelling of any of its members. Any person suspended, or expelled from the Association or from the Institute during the term of this Agreement shall forfeit all rights under this Agreement until reinstated. When final action is taken by either party the other party shall be so notified.

Sec. 19: This Agreement is intended to apply with respect to residents of the Province of Prince Edward Island only, and no person who is not a resident of the Province of Prince Edward Island may become or continue to be a Corporate Member of the Institute under the provisions if this Agreement, but may continue to be a Corporate Member of the Institute and/or a member of the Association on the same conditions as if he had been admitted as a Corporate Member of the Institute and/or a member of the Association without reference to this Agreement.

IN WITNESS WHEREOF these presents have been duly executed on behalf of the parties hereto on the date and at the place first above written.

THE ENGINEERING INSTITUTE OF CANADA

....
President

In the presence of:

....
General Secretary

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ASSOCIATION OF PROFESSIONAL ENGINEERS OF THE PROVINCE OF PRINCE EDWARD ISLAND

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THIRTY-FIVE YEARS AGO

Comment on the Journal of September, 1922

The Institute's annual general and professional meeting was held in Winnipeg on September 5, 6, 7, 1922, so the contents of the *Journal* for that month was drawn from the papers to be presented there, five of them, plus one read before the Saskatchewan Branch in Moose Jaw the previous July. The wide field of engineering which the Institute covers can be seen from the titles of the papers, somewhat condensed:

Extensions to the Winnipeg Hydro-electric System, E. V. Caton, M.E.I.C.; Moncton Yard and Engine Facilities; S. B. Wass, A.M.-E.I.C.; Box Car Unloaders for Grain, Fred Newell, A.M.E.I.C.; Disintegration of Cement by Alkaline Waters, T. Thorvaldson; Turbines for the Manitoba Power Company, H. S. Van Patter, A.M.E.I.C.; Fallacies in Proportioning Concrete, G. M. Williams, A.M.E.I.C.

When Winnipeg built its hydro-electric plant in 1911, it provided space for sixteen units but installed only eight. Now it was adding the other eight units. These were horizontal shaft, double runner turbines rated at 6,800 hp. and directly coupled to 6,500-kva. generators. On test, the turbines actually developed 7,800 hp. at full gate. It was not possible to measure their efficiency, but the guarantees were: full gate, 80 per cent; 0.85 gate, 85.5 per cent; 0.80 gate, 85 per cent; 0.70 gate, 82 per cent; and 0.60 gate, 80 per cent.

Moncton "is the most important railway junction point in the Maritime Provinces", and as such requires ample yard facilities, which it lacked prior to 1922. The general layout of this new yard for the Canadian National Railways was made by C. B. Brown, M.E.I.C. There do not seem to have been any particularly novel features in its design, but it was a fairly sizeable job, with all the necessary buildings as well as trackage. There was no hump; this was before the days of gravity switching. There were seven miles of track in this extension to the old yard. Grading required the removal of 158,000 cu. yd. and the buildings accounted for 5,300 cu. yd. of concrete, 1,200,000 bricks and 1,400,000 ft. b.m. of lumber and 8,300 sq. ft. of glass.

Judging from Mr. Newell's paper, the unloaders which he describes must have been among the first built anywhere. They were designed jointly by C. D. Howe & Co., and Dominion Bridge Company, for installation at one of the Port Arthur elevators, and would empty a car completely in about four minutes.

Professor Thorvaldson's paper was a scholarly disquisition based on all the information he could gather from the literature and particularly on experiences with concrete in the Prairie Provinces. He concluded that 'the sulphates in alkaline waters are responsible for most of the disintegration of concrete, but warns the reader that "one must not draw the conclusion the . . . statement (in the paper) explains everything about the disintegration of concrete". There are other contributing factors.

The turbines of the Manitoba Power Company at Great Falls were notable because they were among the first, if not the first, of those with propeller type runners to be built in Canada. Mr. Van Patter compares them with the Francis-type runner turbines in the Cedar Rapids plant of the Montreal Light, Heat and Power Co. on the St. Lawrence River, which would give about the same power as these propeller turbines if installed at Great Falls. The great advantage of the latter is their higher speed and consequent reduced weight and cost. The higher speed also means a smaller and cheaper generator. Other improvements in the Great Falls turbines were the use of the Moody cone draught tube, a lighter gate ring built into the concrete, and changes in the governor and the lubrication systems. Tests at Holyoke on proto-type propeller runners gave a maximum efficiency of 88 per cent.

In his paper Professor Williams reviews a number of methods of proportioning concrete and comes to the conclusion, not surprising, that they are all imperfect, even the water-cement ratio method, quite novel in 1922. He points out wherein each falls down, and concludes that there is nothing better than making experimental mixes of the cements and aggregates which will be used on the job.

Award to H. J. Cambie

J. H. Cambie, M.E.I.C., "that grand old pioneer whose guiding hand and far-seeing vision was so largely responsible for making the shores of Burrard Inlet the terminus of a mighty railway" was the first recipient of the annual medal of the Hudson's Bay Company. Mr. Cambie went to the Pacific Coast in 1874. The presentation of the medal was made at a meeting of the Vancouver Pioneers Association and duly recorded in this *Journal.*

Lakehead Branch Set Up

The Winnipeg meeting authorized the setting up of the Lakehead Branch. The petition for the establishment, rather an ornate document, is reproduced in this *Journal*, with the comment that "the names of the signatories (can be) easily recognized". Well, maybe, but to me a good many are undecipherable. It seems that the more important a man, the more illegible his signature.

The Cape Breton Branch had made a trip to Louisbourg to visit the ruins of the fortifications there. The weather was wet and foggy, but "though wet externally and comparatively dry internally, the day was considered . . . successful, and it is hoped that it helped the individual members to realize that his professional associates . . . have a human side under their business armour".

Wilson Taylor, A.M.E.I.C., was back in the correspondence column with another long letter about latent heat, this time mostly with respect to its role in meteorological phenomena. Some day I must get one of my friends skilled in thermodynamics to read this letter and Mr. Wilson's previous one in the July 1922 issue of the *Journal*, and translate them into language I can understand, if possible.

R. DeL. French

Editor's Note: This is the last review of *Journals* of Thirty Five Years Ago which Professor R. DeL. French prepared before his death in May, 1956. The editors have enjoyed presenting his reviews, with his characteristic touches of humour and perception. They think *Journal* readers have appreciated them too. It is hoped that arrangements can be completed to continue this column through the services of another reviewer.

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations

ONTARIO

(Abstracted from the bulletin of the Association of Professional Engineers of Ontario)

"Third Force"

A prominent Canadian industrialist recently summed up the status of today's professional engineer in industry. He said: "Professional men are a group themselves—a major one—*a third force* in industry. I like to think of them as representing the "third estate" in modern industrial society, which is made up of management, employees and the professionals.

Today, there is an undeniable dependence by modern business and industry upon trained professional people. The professional employee today represents one of the most sought after and valuable commodities in our economy. Because of this demand by industry for professional engineers, there are many opportunities, and along with them there are many responsibilities.

Industry expects the professional person to identify himself with the enterprise —to find out all he can about the nature and objectives of the business in which he is employed, and to integrate this knowledge into his thinking, so that his work contributes effectively to the overall success of the enterprise.

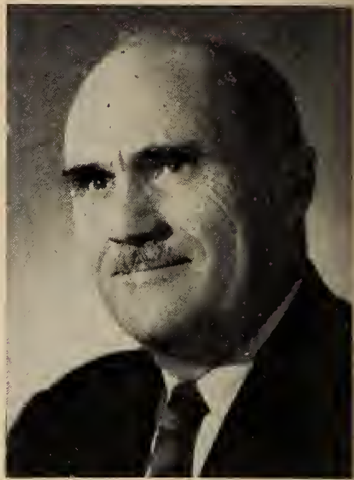
Industry expects thte professional man to be *professional.* Education or long experience do not in themselves create a professional man. The professional must develop his own technical and creative abilities. He must also learn how to inculcate and develop them in others with whom he is associated. He must be able to make his projects clear, not only to other professionals, but also to the non-professionals with whom he works.

In addition, he should take active part in professional and technical societies, in educational and social service activities, and in all the other undertakings which contribute to his own professional and personal development.

Industry expects and demands of its professionals the highest standards of thought, workmanship and integrity. The engineer sets his work objectives and gets his ability to perform them properly from knowledge, standards, goals and requirements of his profession. He must so govern himself that he will be sought after for the knowledge he has acquired in his profession.

Industry also has a right to expect the professional employee to be proud and loyal to his company, and to recognize his place in it.

B. R. Lachapelle, P.Eng.



J. Barselo, P.Eng.

N. Prefontaine

Announcement by C. A. Peachey president of the Corporation of Professional Engineers of Quebec of the recent appointment of Norbert Prefontaine, M.A., as public relations officer of the organization was made in the August issue of the Journal. During the last year, the Corporation has also appointed B. R. Lachapelle, P.-Eng., as specialized services officer and J. Barcelo, P. Eng., as registrar. The 12-member permanent Corporation staff is headed by P. Bournival, P.Eng., general secretary.

Counterbalance

To counterbalance, as it were, the five foregoing demands by industry, there are five similar expectations by the engineer. These have already been covered in previous bulletins; but we shall recall them briefly:

Stability of employment; adequate compensation for degree of responsibility; recognition of professional engineering as creative work; breakdown of a job and acknowledgement of achievement to ensure that an individual is gi en the feeling of responsibility for h specific contribution; a system of goc communications between manageme and engineers to keep the engineers a vised of long-term planning and con pany policy.

Misemployment

There is another duty that indust owes to its professional engineers. should provide opportunity for them work at professional assignments, a not assign them sub-professional tas that could be carried out by engineeri technicians. When we come to look in his situation, we are apt to find, in practically every company, many cases of *misemployment* of engineers, where engineers are engaged in duties which fail to extract the most value out of their professional talents or training. It has been shown by recent surveys that engineers are being used in at least 75 non-engineering jobs in a variety of industries.

In such cases, an engineer could accomplish considerably more in his own specialized sphere if he had suitable trained assistants. In many cases professional engineers with special creative talent are given such increative duties as making drawings, checking and computing – tasks which could well be turned over to others trained especially for these specific jobs.

Elimination of engineer misemployment will be of great benefit to industry, both economic and internal. Such benefits would include lower engineering costs per unit, increased engineering productivity, greater flexibility in the application of technology to products and processes, and lower turnover of professional manpower.

Management, by becoming increasingly aware of the funadmentals of "professional recognition" from the engineer's viewpoint, can take a big step along the way to overcoming the engineer shortage.

Industry will not be faced with the problem of inducing more bright, ambitious young men and women to enter technical and professional engineering fields, for these young men and women will begin to look upon these fields as areas of choice for an industrial career.

Engineers in The News

Robert E. Lawrence, P. Eng., has resigned as vice-president of Dade Petroleum Inc., and as managing director of Mines Development International Inc., to accept the offer from the Honduras Government to take the office of Inspector General of Mines under the Minister of Natural Resources. His headquarters are in Tegucigolpa, Honduras.

Mr. Lawrence writes that his specific task is to encourage the development of the country's large resources. To this end he is at present drafting proposed legislation aimed at encouraging foreign capital to invest there. He is also gathering data on known deposits of commercial minerals as a source of information for visiting engineers. Mr. Lawrence adds that he would like to see Canadian capital take an interest in that part of the world.

D. N. Jeffs, is located in Uranium City, Sask., where he is mine geologist with Lake Cinch Mines Ltd. He obtained his bachelor's degree in mining geology from the University of Toronto and later his Master's degree in economic geology from Queen's. Previous to moving to Saskatchewan, he was with Violamac Mines Ltd., in Toronto.

B. H. McGregor, has been named as sales engineer in the Electronics Division of A. C. Wickman Limited, Toronto. In his new position he will specialize in the application of Brush direct writing recording systems and allied products.

Mr. McGregor graduated in electrical engineering from the University of Toronto in 1947 and has since followed his profession in the electronics division of the Northern Electric Co. Ltd., with Rogers Majestic Electronics Ltd., and most recently with R. H. Nichols Ltd.

H. B. Ashenhurst, has resigned his appointment as co-ordinating engineer for the City of Hamilton and has opened a practice as a consulting professional engineer and Ontario Land Surveyor. His office is at 363 North Shore Blvd., West, Aldershot, Burlington, Ontario.

Andrew L. Leith, has accepted the position of mechanical engineer with Baker Platinum of Canada Ltd., at 512 King Street East, Toronto. He was formerly with the engineering staff of Ontario Hydro.

R. F. Day, has joined the field engineering staff of Alchem Limited, Burlington, Ontario, to which town he has moved. Mr. Day was formerly with the Honeywell Controls Hamilton office.

Andrew D. Miller, consulting electrical engineer, announces his new address at 1122 Bedbrook St., Ottawa 3, Ont.

G. R. Shantz, has returned to Canada and is employed in Maitland, Ont., at the Acrylic Fibre Plant of DuPont Co. of Canada (1956) Ltd.

H. B. R. Mattson, is now living in Windsor, Ont., where he is general manager of the Township of Sandwich East Public Utilities Commission. Prior to accepting this position, Mr. Mattson was manager of the Preston P.U.C.

T. F. Williscroft, has transferred from the Longlac Pulp & Paper Co., at Terrace Bay, Ont., where he was maintenance engineer to the Coosa River Newsprint Co., Coosa Pines, Ala. He is employed as a field lubrication engineer.

S. McCune, president of McCune Engineering Limited, informs us that the company has moved to enlarged quarters at 170 University Avenue, Toronto, where the consulting practice will be continued as designers and supervisors of construction for mining, ore beneficiation and industrial plants.

In addition to Mr. McCune and A. E. Salter, vice-president of the company, the following professional engineers are members of the staff: J. W. Cumming, chief engineer; Anton Kowbel, and F. D. Greenwood, project engineers; W. G. Moorehead, chief supervising engineer; and P. S. Joffray, design engineer.

P. G. Campbell, P.Eng., of Ontario Hydro, Toronto, has been appointed as director of construction for the commission. He succeeds **John E. Stark,** P.Eng., whose retirement takes place shortly following nearly 40 years service on the engineering staff of H.E.P.C. of Ontario.

Mr. Campbell is a native of Halifax and a graduate in civil engineering of the Nova Scotia Technical College. He joined Ontario Hydro in 1943 and has been with the Commission since that time with the exception of service in the Royal Canadian Navy and with the Federal Department of Mines and Resources. His work with Hydro has been in many parts of the Province and previous to his recent appointment was construction engineer in the generation department of the Construction division.

BRITISH COLUMBIA

Engineers in the News

J. Howard Bennett, P.Eng., was appointed assistant registrar of the Association at the last meeting of Council. Mr. Bennett graduated from the University of British Columbia in mining engineering in 1942. He has not been active in the profession for the last year. During this time he held a teaching appointment at Gladstone High School in Vancouver. Previous to that he was with Violamac Mines at New Denver, B.C. and from 1948 to 1952, he was inspector and resident engineer for the Department of Mines, Province of British Columbia. He has been registered as a Professional Engineer since 1949.

Mr. Bennett assumed his duties on July 1.

R. P. Henderson, formerly of New Westminster, has been appointed district engineer, Harbours and Rivers Engineering Branch of the Federal Department of Public Works.

L. D. Roberts, has been appointed project engineer in the Toronto area for Central Mortgage and Housing Corporation.

W. G. Whishaw has left the Fresnillo Company and is now acting as a consultant for the United States Steel Corporation in Mexico.

H. E. Sladen has been appointed assistant superintendent, distribution engineering, with the B.C. Electric Company Limited.

A. V. Gallon has received the appointment of senior civil design engineer with the B.C. Engineering Company Limited.

J. H. MacFadden has been appointed research engineer in the research and development division of the Consolidated Mining and Smelting Company at Trail, B.C.

R. G. Foxall has received the appointment as assistant civil engineer, power development division, with the B.C. Power Commission.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Duncan Lennox McLaren, M.E.I.C., of the Canadian General Electric Company Limited, Peterborough, Ont., died at his home in that city on June 13, 1957, Mr. McLaren retired from the company earlier this year due to ill health, relinquishing his post with the marketing section, apparatus department.

Mr. McLaren was born at Perth, Ont., on January 1, 1892. He studied engineering at the University of Toronto, gaining the degree, B.A. Sc., from that University in 1914. For the next two years he followed the C.G.E. test course at Peterborough. With the Canadian General Electric Company Limited during his entire career, one of his most recent endeavors was his contribution to the design of the water generator.

Early in his career, in 1925, he transferred from the engineering department to direct his efforts to sales, and moved from Peterborough to the generator section at head office, Toronto. He was manager of the generator division of the company in 1949 and five years later was named manager of sales in charge of large motors and generators. Mr. McLaren returned to Peterborough in 1954, after thirty years and at that time was named manager of sales in charge of large motors and generators.

Mr. McLaren joined the Institute as an Associate Member in 1919. In 1940 he transferred to Member. He attained Life Membership in the Institute in 1955.

Air Vice-Marshal Clarence A. Cook, O.B.E., M.E.I.C., whose promotion from Air Commodore was made a few weeks before his death, died on July 24, 1957 at Ottawa.

Mr. Cook was born at Saskatoon, Sask., on November 20, 1907. He attained a bachelor of civil engineering degree at the University of Saskatchewan in 1933. He also attended the College of Education of the University of Saskatchewan and was engaged for a time as a teacher on the staff of Bedford Road Collegiate, before joining the R.C.A.F. in 1939. Overseas during the battle of Britain in 1940 he served as an engineering officer with No. 112 Army Cooperation Squadron. On his return to this country he became staff officer at various stations and headquarters and later took over a position in the directorate of Postings and Careers, at Air Force Headquarters, Ottawa. In 1948 he was posted to the Canadian Joint Staff, Washington, D.C., returning to the Air Material Command headquarters as senior logistics planning officer.

For distinguished wartime service Air Vice Marshall Cook was appointed an officer of the Most Excellent Order of the British Empire in 1946. In 1952 he received the appointment of chief logistics officer at Royal Canadian Air Force Headquarters, Ottawa, which he retained until his appointment as Air Vice Marshall and Air officer commanding the Air Material Command in 1957.

Air Vice Marshall Cook joined the Institute as an Associate Member in 1938, and transferred to Member in 1940.

Thomas Hogg, M.E.I.C., project engineer for the B.C. Power Commission, at Victoria, B.C., died on June 28, 1957, in that city.

Originally from Great Britain, Mr. Hogg was born at Ushaw Moor, County Durham, England, on November 7, 1904. He attended the Sunderland technical school and the Bede Collegiate Institute at Durham and was granted a national certificate of the Institution of Mechanical Engineers in 1925, and was for a number of years also engaged as a pupil with a firm of mechanica engineers. Working in England for th first few years of his graduate caree he migrated to Canada early in th thirties. Having served as chief draughts man for the Department of Natural Re sources at Regina, Sask., for five and half years he transferred in 1937 to th Water Rights Branch at Regina to carr out water development work in the Prov ince of Saskatchewan under the Prairi Farm Rehabilitation Act.

During World War II he became ad ministrator officer to Major Gen eral W. W. Foster, D.S.O., special com missioner for defence projects in North west Canada at Edmonton, Alta., an attained the rank of captain.

After the war he became executiv assistant with the British Columbia Pow er Commission, Victoria, B.C. In 194 he was with the construction departmen of the Commission and later worked o the Watshab Hydro Project at Needle B.C., and as resident engineer on th John Hart project at Campbell Rive B.C.

Mr. Hogg joined the Institute in 193 with the status of Associate Membe He was transferred to Member in 194

H. Leonard Watts, M.E.I.C., frequenc standardization project manager fo Brantford, Ont., and district, died at hi home at Stoney Creek on April 12, 195

Mr. Watts was born at Toronto o October 25, 1907. He attended King Ed ward Public School and St. Andrew College before graduating from the Un versity of Toronto with a B.A.Sc. in met allurgy in 1931. He entered govern ment service and became assistant to th chief of the Bureau of Mines at Ottaw He retained this position from 1938 t 1948 with the exception of five and a half years during World War II, whe he served overseas with the Royal Can dian Engineers. Mr. Watts took part i the raid on Dieppe, France, durin which time he was wounded. He hel the rank of major on demobilization.

Brief periods of his career were als spent with the National Sewer Pipe Con pany Limited at Hamilton and wit Shell-Bar Limited, New Toronto, durin the thirties and with the Central Mor gage and Housing Corporation at Va couver during 1948 and 1949.

Joining the Hydro-Electric Pow Commission of Ontario in 1949, he acte as assistant project manager during th frequency standardization program in th City of London and Windsor, and be came project manager in 1954 for th operation in Hamilton and district.

Mr. Watts joined the Institute as Member in 1952.

In the June issue of the *Journal* it wa reported that Harold Forsyth Finnemor M.E.I.C., retired chief electrical enginee Canadian National Railways, Montrea died on April 8, 1956. The correct da was April 8, 1957. The *Journal* regre the error.

A.V.M. C. A. Cook, O.B.E., M.E.I.C.

D. L. McLaren, M.E.I.C.

Personals

News of the Personal Activities of Members of the Institute

C. K. McLeod, M.E.I.C., elected vice-chairman of the board of directors of the Permutit Company of Canada earlier this year, has been elected chairman of the board of directors and will continue to serve the organization as a consultant.

Mr. McLeod was also elected president of Walter Kidde and Company of Canada Limited early in 1957. He has been associated with that Company as well as the Permutit Company since 1925.

He is a past vice-president of the Institute.

I. J. Hamill, M.E.I.C., has been appointed executive vice-president and managing director of Walter Kidde and Company of Canada Limited.

Mr. Hamill joined the organization eighteen years ago and was transferred to Canada a year ago. Prior to this move he served as manager of the aviation division of Walter Kidde and Company Inc., New York.

P. E. Cooper, M.E.I.C.

W. C. M. Luscombe, M.E.I.C., of Dominion Structural Steel Limited, has been appointed to the position of assistant secretary of the company at the head office in Montreal. He will continue to hold office as manager of engineering, research and development, which department was newly formed in 1955. These duties include the development of new products and new plants.

Mr. Luscombe joined the staff of Dominion Structural Steel in 1955, at Montreal. He was formerly associated with the Dominion Textile Company Limited at Montreal and Magog, Que., and the Aluminum Company of Canada at Montreal.

He is a graduate of Queen's University, class of 1941 in electrical engineering.

Paul E. Cooper, M.E.I.C., formerly president of Crown Zellerbach Canada Limited, has been appointed a director and executive vice-president of Sandwell and Company Limited, consulting engineers of Vancouver.

Mr. Cooper has been associated with the pulp, paper and allied forest industries for more than thirty years in Canada, the United States and abroad.

Mr. Cooper is a past chairman of the executive committee of the Canadian Pulp & Paper Association.

R. E. Tweeddale, M.E.I.C., of Fredericton, N.B., who was formerly assistant chief engineer of the New Brunswick Electric Power Commission has been named chief engineer. he appointment is retroactive to July 1, 1957. He has also assumed the duties of senior executive officer reporting to the Commission.

Mr. Tweeddale is a graduate of the University of New Brunswick where he received a B.Sc. degree in electrical engineering, class of 1935. Prior to joining the R.C.A.F. in 1940 where he served overseas he was employed as district highway engineer with the provincial government. In 1945 he joined the engineering department of the Commission and was later named manager of operations. During the study of the St. John River basin by the International Joint Commission in 1952 and 1953 he served with their engineering work group on a number of important committees in connection with the survey.

Dr. K. R. Rybka, M.E.I.C.

R. E. Tweeddale, M.E.I.C.

Mr. Tweeddale was chairman of the Fredericton Branch of the Institute in 1954.

J. L. Feeney, M.E.I.C., chief engineer of the New Brunswick Electric Power Commission at Fredericton, N.B., whose retirement has been announced, remains with the Power Commission in a consulting capacity until the end of November 1957. Mr. Feeney is responsible for the completion of the Beechwood development, the 135,000 hp hydroelectric development at Beechwood on the St. John River. Two 45,000 hp units of the big project will be joining the Provincial transmission system this year.

During Mr. Feeney's term of office as chief engineer, the 27,000 hp Tobique hydro development was completed and more than 62,000 hp added to the utility's generating capacity.

Prior to joining the Commission's staff as design engineer in 1935, Mr. Feeney had a responsible hand in a number of important engineering and architectural projects in both Canada and the United States.

He is a member of the Advisory Committee of the Atomic Energy Commission for Canada.

Dr. Karel R. Rybka, M.E.I.C., vice-president of Federated Consultants Limited and president of Karel Rybka and Associates Limited, was elected president and director of engineering of Gulf Federated Consultants, Inc. of New Orleans, La.

• PERSONALS

Gulf Federated Consultants Inc., have recently been commissioned by the Morgan City Harbor and Terminal District in Morgan City, La., to prepare a master plan and an economic feasability report, and to engage in any consequent engineering in connection with the development of a major deep draft seaport for the twin communities of Morgan City and Berwick, La. and with the industrial development of the entire region.

Morgan City and Berwick straddle the Atchafalaya River a few miles from the Gulf coast and at its intersection with the Intracoastal Canal. This barge canal is planned to ultimately extend from the Mexican border to Trenton, N.J., and several major sections of it are already in full-scale operation.

T. Blench, M.E.I.C., professor of civil engineering at the University of Alberta, and consulting engineer, is the author of "Regime Behaviour of Canals and Rivers," very recently published by Butterworths, England. The Canadian office is at 1367 Danforth Ave., Toronto.

Commodore (L) William H. G. Roger, M.E.I.C., of Hamilton and Ottawa, electrical engineer-in-chief at naval headquarters, from 1948 until the present, has retired.

Commodore Roger came to this country in 1923 immediately following training at the Heriot Watt Engineering College, Edinburgh, and found work with the Canadian Westinghouse Company, Hamilton, in the engineering department.

His naval career dates to 1937 when he joined the Hamilton division of the R.C.N.V.R. The following year he served as commanding officer of the division. With the outbreak of World War II he began a series of appointments in Canada.

Comm. (L) W. H. E. Roger, M.E.I.C.

P. J. Croft, M.E.I.C.

For his services in Halifax during the war he was awarded the Order of the British Empire.

R. W. McNally, M.E.I.C., has been appointed general sales manager of Mathews Conveyer Company Limited, Port Hope, Ont.

Mr. McNally has been in charge of the Mathews engineering sales office at Hamilton, Ont., since 1947. Prior to that time he was located in the company's Toronto office, as a service engineer.

Mr. McNally graduated from the University of Saskatchewan.

P. J. Croft, M.E.I.C., has been appointed stations engineer with the B.C. Power Commission, following nine years as chief engineer with the Canada Wire and Cable Company, Toronto.

Experienced in the design, development and application engineering of cable and underground transmission, Mr. Croft was also associated with the design and installation of some of the first fully automatic hydro-electric stations in Canada. Eighteen of his thirty-six years in the electrical industry were spent with the Power Corporation of Canada in station design, transmission, distribution and system planning work.

In his new post Mr. Croft becomes responsible for station design in the Commission's heavy program of generating plant construction.

W. L. Bunting, M.E.I.C., previously project engineer for Defence Construction, Winnipeg has been appointed engineer in charge of structural design, for the City of Winnipeg Hydro Electric System succeeding H. Jorgenson who has returned to Norway.

Mr. Bunting has previously held appointments with the Department of Public Works, Province of Manitoba; with the Municipal District of Flin Flon as municipal engineer; with the firm of Ducks Unlimited (Canada) at Regina, Sask., as chief engineer; and with the Hudson Bay Mining and Smelting Company.

W. L. Bunting, M.E.I.C.

G. M. Rose, M.E.I.C.

Gordon M. Rose, M.E.I.C., who was for several years chief re-inforced concrete engineer with the firm of W. V. Zinn and Associates, Toronto, has returned to Great Britain to continue his career. At present in London, Eng., he is associated with Procon (G.B.), the British subsidiary of the American firm of oil refinery consultants, in connection with civil engineering work on contracts in the United Kingdom, Europe, the West Indies and South America.

E. L. Neal, M.E.I.C., has been appointed general manager of the Gaspesia Sulphite Company Limited.

Mr. Neal, who is a graduate in mechanical engineering of Queen's University, class of 1938, has been filling the office of mill manager for the Anglo-Newfoundland Development Company

We are exhibiting at Canada's Power Show, Exhibition Park, Toronto, Oct. 21-24, 1957.

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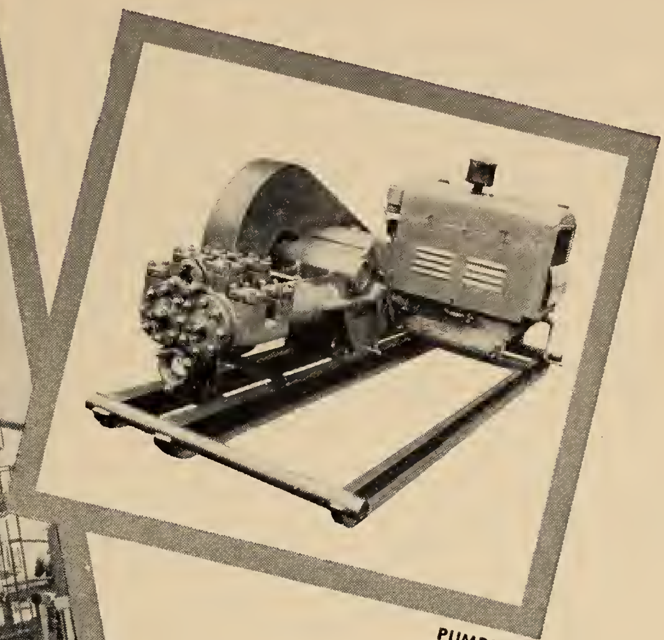
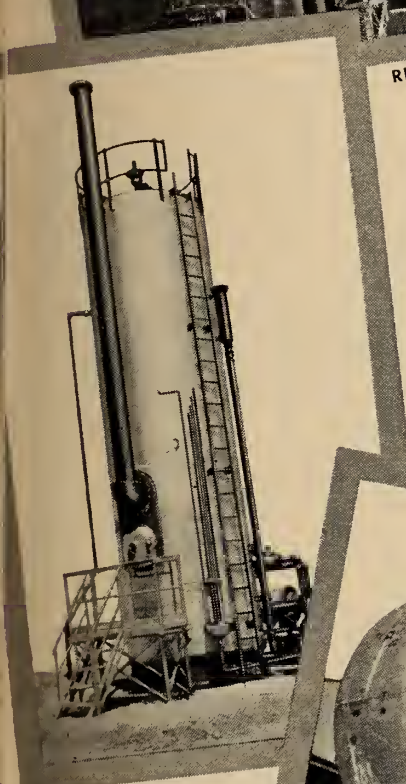
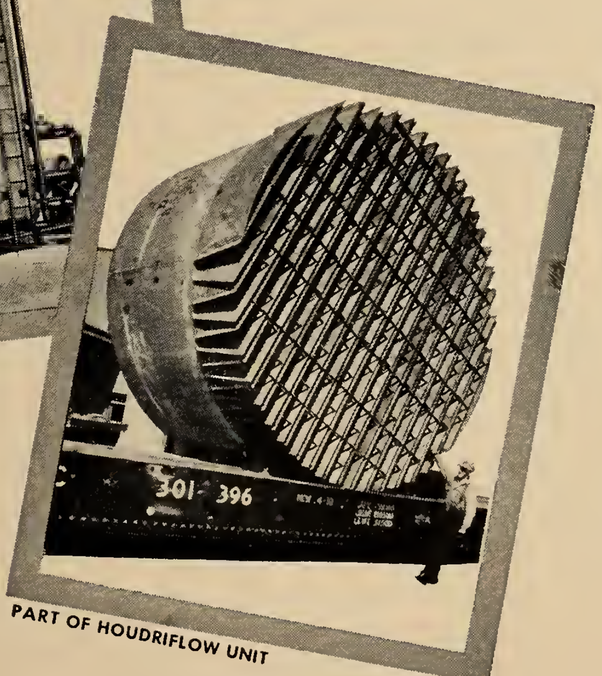


PUMPS



TREATER UNITS



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Dominion Bridge

Limited, at Grand Falls, Nfld., since 1952. He was an assistant general superintendent with the Anglo-Canadian Pulp and Paper Mills at Quebec, at an earlier period in his career.

J. Harold Wallis, M.E.I.C., who retired from Dominion Engineering Works Limited, Montreal as vice-president and manager of the power crane and shovel division in 1956, has been appointed president of Power Shovel Cranes Ltd., at Montreal.

Mr. Wallis was general manager of the Dominion Hoist and Shovel Company Limited from 1931 to 1953. When that firm was absorbed into the parent company, Dominion Engineering Works Limited, he became vice-president and manager of the power crane and shovel division.

Ian F. McRae, M.E.I.C., a vice-president of the Canadian General Electric Company has been elected to the first vice-presidency of the Canadian Manufacturers' Association.

In 1955 Mr. McRae was chosen to head the General Electric Company's engineering team assigned to design, engineer and construct Canada's first nuclear reactor for power purposes.

Mr. McRae has served the company since 1925. Manager of the firm's largest plant, at Peterborough from 1941 to 1950 he was two years later sent on loan to the Government of Canada as director of the gun division of the Department of Defence Production.

J. A. Tames, M.E.I.C., has been appointed manager of the Canadian Westinghouse Company eastern district.

Mr. Tames, who joined the company in 1925 will be directly responsible for sales of Westinghouse electrical apparatus products in Quebec and part of Eastern Ontario, where he will be senior representative in that area.

Located at Vancouver with the firm for many years Mr. Tames has been extensively associated with power sales and apparatus sales.

M. D. E. Robinson, M.E.I.C., has been named to the post of assistant manager, engineering, with the Linde Air Products Company, division of Union Carbide Canada Limited, Toronto.

Mr. Robinson graduated from the University of British Columbia in 1947 with a master of science degree in metallugical engineering and joined the Linde Air Products Company at that time. He served as engineering service representative in British Columbia for several years and prior to his present appointment was manager, engineering service, western district.

C. W. E. Locke, M.E.I.C., is working through an appointment from Sandwell International Limited, consulting engineers, as mill manager at the Khulna pulp and paper mill project now under construction in East Pakistan for the Pakistan Industrial Development Corporation.

Sandwell International was formed in 1955 to provide management services and was recently awarded a management contract by the Pakistan Industrial Development Corporation in connection with the new pulp and paper mill.

Mr. Locke is a graduate of the University of British Columbia, class of 1930. He has latterly acted as resident manager, general manager and plant engineer at a number of British Columbia coastal mills.

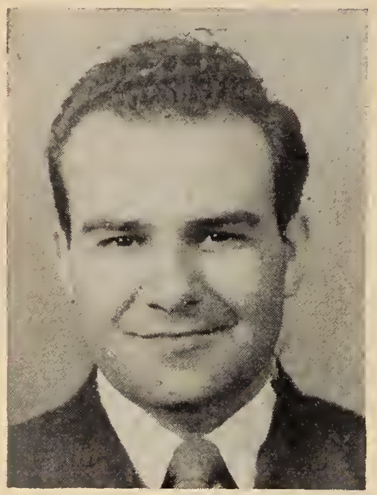
Among them are Pacific Mills Ltd., Ocean Falls, B.C., Bloedel, Stewart and Welsh Company Ltd., and MacMillan and Bloedel Limited, Nanaimo, B.C.

G. L. MacKenzie, M.E.I.C., active in the work of the Prairie Farm Rehabilitation Administration for twenty years was appointed director of the organization earlier this year.

Mr. MacKenzie gained his engineer-

ing training at Queen's University, became a certified Dominion Land Surveyor. In 1920 he moved to Western Canada and to P.F.B.A. in 1937, serving as district engineer in Manitoba, office engineer at Regina, and becoming chief engineer in 1946.

While filling this office, Mr. MacKenzie was instrumental in the construction of the St. Mary and Bow River irrigation projects in Alberta.



R. P. Lynch, M.E.I.C.

During this time he served in numerous capacities for the Dominion government. Mr. MacKenzie is chairman for Canada on the international engineering boards on Western Water References, Waterton-Belly Rivers Reference and Souris-Red River Reference, under the International Joint Commission.

Mr. MacKenzie was also appointed Canadian delegate to the United Nations conference on conservation and utilization of resources in New York in 1949.

On a special assignment he investigated and reported on works for flood relief on the Red River at Winnipeg for the department of resources and development between 1950 and 1953.

H. R. Skinner, M.E.I.C.

Hugh R. Skinner, M.E.I.C., has accepted the post of heating equipment sales engineer with The Winnipeg Supply and Fuel Company Limited.

A 1949 graduate in mechanical engineering from the University of Saskatchewan, Mr. Skinner has spent the past six years in the mechanical contracting field and was associated with the firm of Waterman-Waterbury Manufacturing Company Limited at Regina and Winnipeg.

R. P. Lynch, M.E.I.C., assistant construction engineer with the Department of Public Works of the Province of New Brunswick at Fredericton, N.B., is chairman of the Fredericton Branch of the Institute for the 1957-58 term.

A native of that eastern city, he is also a graduate of the University of New Brunswick, class of 1947 in civil engineering.

Engaged in his present work since the beginning of his career he was originally resident engineer on survey and construction.

Mr. Lynch joined the Institute as a

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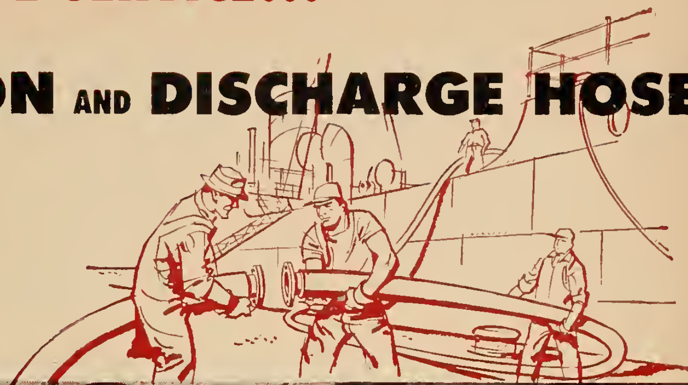

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student member in 1946, and transferred to Junior in 1949.

H. A. Mullins, M.E.I.C., of Du Pont Company of Canada Limited has been appointed supervising engineer of construction. He formerly served the organization as purchasing agent for equipment in the purchasing and traffic department.

Mr. Mullins is a graduate in electrical engineering from the University of Manitoba. In addition to his background in a number of industries, his experience with Du Pont of Canada has been in engineering and purchasing.

Mr. Mullins is a councillor representing the Montreal Branch of the Institute for a three-year term which began in 1956.

R. N. Boyd, M.E.I.C., has been named to the post of supervising engineer of design services with Du Pont of Canada Limited, engineering department at Montreal.

A B.Sc. graduate in mechanical engineering from the University of Toronto, class of 1939 Mr. Boyd began his career with the Hydro-Electric Power Commission of Ontario. He joined the Du Pont Company in 1941. He was appointed a supervising engineer on design for the organization in Montreal in 1954.

R. C. Thurber, M.E.I.C, who has since 1951 carried out the duties of materials engineer with the Department of Highways, Province of British Columbia, has formed a company of consulting engineers at Victoria, B.C., known as R. C. Thurber and Associates. The firm will specialize in soil mechanics, foundations for bridges and buildings, landslides, slope stability work and concrete and affiliated work in civil engineering in connection with dams, concrete construction and road building.

Second member of the firm is W. C. Jones, who holds an M.Sc. degree in geology from the University of British Columbia, class of 1953.

D. D. Coffey, third member of the company is a 1948 graduate of Sydney University in Australia. He was formerly with the Department of Highways Testing Branch.

Mr. Thurber is a graduate of the University of Alberta class of 1949. He specialized in soil mechanics and testing at the University of Alberta and worked on various research projects under Dean Hardy and for the National Provincial Research Council. He became associated with the Department of Highways in 1949 working as a soils engineer.

Cyril Fry, M.E.I.C., of Gravenhurst Ont., is president of the Central and Northern Ontario Film Federation.

When the Georgian Bay District Federation of Film Councils was formed, he was named chairman, serving in this office until 1955. At this time the organization merged in the larger group now known as the Central and Northern Ontario Film Federation.

Mr. Fry has been interested in films for many years and suggests that in the interest of the engineering profession and in the search for potential technical men, films could bring engineering achievements to the schools in a way that is impracticable by other means.

John S. Ellis, JR. E.I.C., has joined the firm of J. D. Lee and Company Limited, consulting engineers, at Kingston, Ont.

Mr. Ellis graduated with a B.Sc. in civil engineering from Queen's University in 1948 and qualified for an M.Eng. degree at McGill University the following year. Gaining experience with the Shawinigan Engineering Company and the firm of H. G. Acres and Company, Niagara Falls, Ont., he has since then carried out studies at St. John's College, Cambridge, Eng., as a winner of the Athlone Fellowship in 1954.

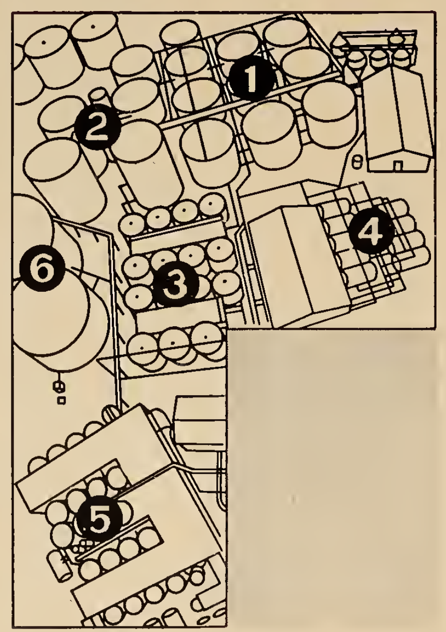
J. N. Buckley, JR.E.I.C., formerly with the Ideal Welding Company Limited, Toronto, as a design estimator, has left that place of business and is at work in London, Ont. He is associated with the

Water-tower view of PERMUTIT water-treatment equipment at Gulf States Utilities Company's Louisiana Power Station, North Baton Rouge, La. Engineered and constructed by Stone and Webster Engineering Corp.

12 million gallons of make-up per day

This station needs a *large volume* of water because it sells its steam to a refinery for process and requires 100% make-up. It needs *high-grade* water because it has adopted high-pressure boilers and turbines. It needs *efficient* treatment because it uses muddy Mississippi River water and well water with high solids and silica.

HERE'S HOW THIS 26-YEAR OLD PLANT HAS KEPT UP TO DATE *(see diagram)*:



1. Original *batch coagulation and settling tanks.* Some are still used for secondary treatment of river water to reduce silica.

2. The 1931 roughing sedimentation tanks were converted to modern up-flow *Precipitators* in 1938 . . . cutting hardness 20%, turbidity 40%—and tripling capacity.

3. *Gravity filters* polish the clarified river water prior to softening.

4. Old Zeo-Dur® *zeolite softeners* were converted to new Zeo-Karb® exchanger in 1937 . . . boosting each unit's capacity 55%.

5. *Demineralizers* for new high-pressure boilers were added in 1955. They treat 3500 gpm, reduce dissolved solids of well water from 271 to under 2.0 ppm and silica from 25 to less than 0.1 ppm. Completely automatic PERMUTIT controls determine end-points, rinse, backwash and regenerate units and return them to service . . . even prepare regenerating solution.

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• PERSONALS

Allen Tank and Welding Company, Limited in that city.

Mr. Buckley is a 1949 graduate in mechanical engineering from the University of Manitoba.

E. H. Wilson, JR.E.I.C., has been appointed plant manager with the firm of Bestpipe Limited, at Toronto.

Mr. Wilson, a Queen's University graduate, class of 1951 was formerly associated with the North American Cyanamid Limited, Niagara Falls, and with the Niagara Concrete Pipe Company Limited, St. Catharines, Ont.

S. R. Price, JR.E.I.C., assistant city engineer for four years has taken over the appointment of city engineer at Niagara Falls, Ont.

A graduate of Queen's University in civil engineering, Mr. Price has gained experience in several engineering positions. One and a half years with a firm of consulting engineers at St. Mary's, Ont., he served as assistant town engineer at Weston, Ont., for one year.

Later he was for two and a half years assistant city engineer at Belleville, Ont.

W. C. Sinkins, JR.E.I.C., formerly of the firm of B. A. Hastings, consulting engineer, of London, Ont., has accepted a post with the London Steel Construction Company Limited, also in London.

Mr. Sinkins is a graduate of Queen's University, class of 1951 and was at one time a draughtsman with the firm of Bestpipe Limited, at Toronto.

John W. Francis, JR.E.I.C. has been appointed sales engineer at the Montreal office of Forano Limited, in the power transmission and materials handling division. Mr. Francis is a graduate of McGill University, obtaining a B.Eng. degree in mechanical engineering in 1950.

In his engineering career to date he has been associated with the construction, forestry and plant engineering fields.

G. T. Keys, JR.E.I.C., who has been residing at Kingston, Ont., associated with the Pulp and Paper Research Institute of Canada as an hydraulics engineer now lives in Montreal. He has accepted an appointment with the Canadian Pulp and Paper Association as mechanical engineer.

Mr. Keys obtained an M.A.Sc. degree in mechanical engineering at the University of Toronto in 1952.

M. E. M. Gibson, JR.E.I.C., formerly of Dublin, Ireland, is working as assistant resident soils engineer on the Bersimis No. 2 hydro-electric project at Labrieville, Que. He is employed by H. G. Acres and Co. Ltd., of Niagara Falls. The firm is supervising the soils and foundation section of the work for Hydro-Quebec.

Mr. Gibson graduated in civil engineering from Trinity College, University of Dublin in 1954 and the following year became associated with the firm of Proctor, Redfern and Laughlin, Toronto. He joined his present firm in 1956.

Maurice G. Vezina, JR.E.I.C., is association with the firm of Lalonde and Valois, consulting engineers of Montreal.

Mr. Vezina graduated from Loyola College with a B.A. degree in 1952, from McGill University in civil engineering in 1956. He was awarded a master's degree in sanitary engineering from the Massachussetts Institute of Technology in 1957.

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Provides very high resistance to impact abrasion plus superior strength and toughness that keeps equipment in service far longer than before*

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*oader plates last 8 to 12 months longer

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NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

SAULT STE. MARIE

L. F. MASON-TULBY, M.E.I.C.,
Secretary-treasurer

Mackinac Bridge Site Tour

In warm sunny weather, Saturday June 8, a group of local professional engineers and ladies set off for St. Ignace as guests of the Mackinac Bridge Authority. This event marked the final meeting of the local branch until next fall.

Apart from the appropriate nature of this professional team viewing one of the outstanding engineering projects in the world at the moment, the event was naturally of outstanding interest for those enjoying the trip.

Since H. D. Ellis, chief public relations officer for the Bridge Authority was already well known to the visiting group, his role as host was in keeping with the occasion, and his conduct of the tour was assisted by David L. Bigler, field representative of United States Steel Corporation. This organized trip around the site of the unfinished structure took place on the water, with the touring party carried aboard the sturdy construction tug, "Bridgebuilder-X", belonging to the bridge-building division of U.S. Steel.

In spite of wide publicity already given the partially built giant bridge, some of its staggering dimensions continue to draw gasps from spectators. The main towers rise up skywards 525 feet above the water. This is the equivalent height of a 46 floor skyscraper. Below water level the main pier foundations reach down over 200 feet to rest on solid rock. A shore-to-shore gap of four miles will be spanned, and if we include the shore approaches then the overall length of the structure is five miles. At such a great height, sweeping in mighty curves between the colossal towers, the two main suspension cables appear almost slender. In actual fact each of these has a diameter better than 24 inches.

Mythology and Mackinac

Alongside this mammoth product of his own ingenuity man seems but a tiny ant. As our little tug moved like a speck across the sunny peaceful waters of the Mackinac Straits, awed by the dimensions of the bridge, some of us remembered the earlier history of these parts, particularly in regard to Mackinac Island. In the year 1880 J. A. Van Fleet wrote: "Indian mythology makes this island the home of the Great Fairies, hence the Indians have always regarded it with a species of veneration." We know that in early times Indians passing these shores by water stopped to make offerings to the Great Spirit.

Members of the Sault Ste. Marie Branch and their families enjoyed the Mackinac Bridge tour held June 8. Seen in the background is the base of the main tower of the gigantic structure.

It seems there was always some air of mystery about this area. Now in our time has come the magic of the mighty bridge, fulfilled by the vision of the great state of Michigan with the ingenuity of modern engineering.

Our tug turned from the setting sun and returned the group to St. Ignace. That evening everyone attended a buffet dinner and an evening of good fellowship in Sault Ste. Marie, rounding off the season with the memorable tour of Mackinac.

KINGSTON

D. I. OUROM, M.E.I.C.,
Secretary-treasurer

Annual Meeting

The annual meeting of the branch was held on May 23, 1957 in the Corps of R.C.E.M.E. Officers' Mess at Barriefield. Ninety-two members, wives and guests were in attendance at dinner which was followed by the annual meeting, presided over by the chairman, Col. C. W. Jones. The Duggan Medal and Prize was presented by Councillor H. G. Conn on behalf of the President of the Insitute to Dr. D. T. Wright for his paper "The Design of Compressed Beams".

The election of officers for the 1957-1958 term was held and the following were elected: chairman: J. W. Dolphin; vice chairman: R. B. Wotherspoon; executive: W. B. Rice; W. M. Campbell; and D. C. Macpherson.

The following are the appointed members of the 1957-58 Executive: past chairman: C. W. Jones; councillor: C. H. R. Campling; and sec.-treasurer: D. I. Ourom.

The evening concluded with dancing and refreshments.

Students' Papers Night

The annual Students Papers Night of the Branch was held on March 5, 1957 at Queens University with Col. C. W. Jones in the chair.

Of the many papers submitted, five

• BRANCH NEWS

were selected for presentation as follows: "Audio Noise from Distribution Transformers", by G. Fanjoy; "Catalysis and Core Structure in Catalysts", by D. Woods; "Measurement of Demagnetizing Currents in D. C. Machines", by J. Hunt; "Laying of Submarine Power Cables", by D. A. Croft; and "Hyperbolical Parabaloidal Arches", by J. J. Ryan.

The first, second and third prizes were won respectively by G. Fanjoy, J. Hunt and D. A. Croft.

Metal Cutting Research

Professor W. B. Rice of Queens University gave a paper on March 19, 1957, at Queens University on "Metal Cutting Research". Vice Chairman J. W. Dolphin was in the chair.

Dr. Rice has undertaken the research project, essentially a problem of automation, with Ross Salmon, a McLaughlin Teaching Fellow.

Dr. Rice states that the economic importance of metal cutting is evident when we consider that almost everything we own is directly or indirectly the product of a machine tool. Hence it is not surprising that much effort is being directed towards the automatization of machine tools, while there is considerable discussion of computer control.

"A computer is frequently and correctly referred to as a data processing device. Its output, instruction to the machine tool, is only as satisfactory as the data available to it," he said.

If the aquisition of vital data is to keep pace with the development of new materials, it must be acquired in a rational way. Thus, at Queen's the fundamentals of the cutting process are being studied in the hopes of being able to construct a general theory from which specific data may be readily obtained.

Other Data

"In addition to metal cutting data," Professor Rice added, "we expect to obtain as a by-product, data of considerable value in the fields of plasticity and friction and lubrication. For instance, in metal cutting, the deformation rates are extremely high and of the order of those encountered in explosion. Thus the strength of material data obtained in metal cutting may be of use in rocket or engine design."

The experimental work consists of turning on a lathe carefully prepared specimens under somewhat artificial conditions. The watchwords are care and repeatability. Specimen and tool materials are selected from the same batches for consistency; tools are precisely ground and mounted with extreme care; the cutting and friction forces are accurately measured electronically; and tests are repeated many times to ensure that they are reproducible.

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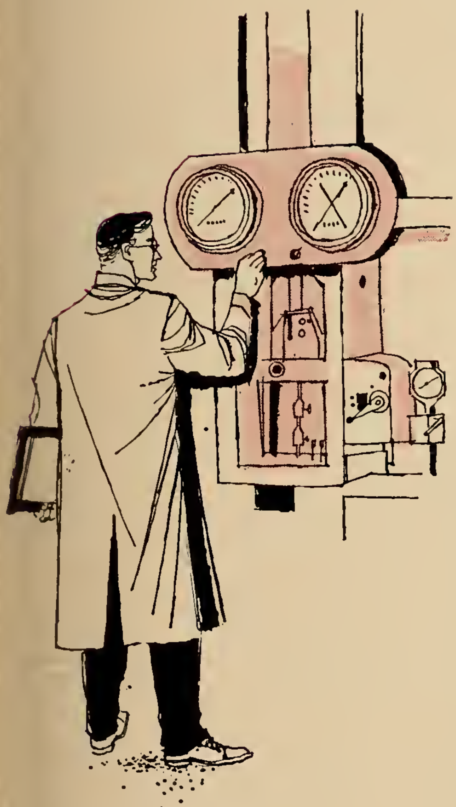

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• BRANCH NEWS

The project is supported by the Defence Research Board and with the exception of one other, is the only fundamental research project of its kind in Canada.

KOOTENAY

G. T. J. HUGHES, M.E.I.C.,
Branch News Editor

Smorgasbord for President

Enroute from the Chemical Institute of Canada conference in Vancouver to the Engineering Institute convention at Banff, President and Mrs. McKillop were welcomed at a smorgasbord supper held at the Trail-Rossland Golf Club on June 7. H. P. Hamilton, retiring councillor, introduced the guest of honour.

The president opened his remarks with a play on the name of Trail and the multitude of engineers along the *trail* who had contributed to the development of the profession and the country at large. He noticed many bridges in B.C., and conjectured that probably engineers were better equipped than any other profession for building bridges of understanding.

Impressed at Advances

Exemplifying his enthusiasm at the accomplishments of the Institute during his term of office, Mr. McKillop enumerated three occasions which had impressed him more than anything else. These were: The ceremony in Montreal on the occasion of the inauguration of the Trans-Atlantic cable when Canadian, British and American engineers shared a telephonic program.

The meeting in Mexico City of the Pan - American Engineering Societies where a high regard for the people of Canada was encountered. It was most important to develop relations between the various societies within our own country, but we also had to make our technical information available to the sister societies in other countries.

The American Society of Mechanical Engineers and the Engineering Institute joint conference at the University of Western Ontario concerning the continuing education of the engineer. Emphasis was laid upon the need for engineers of quality with due regard to the pressing needs of quantity. It was essential that experience should be made available to the teacher. The Institute encouraged deans and heads of universities in coming together to discuss their problems. This was to be brought up again at Banff.

Concerning confederation, the president remarked that the Engineering Institute was awaiting the report of the Dominion Council, of which there would doubtless be further discussion at Banff.

In civilizations past, engineers were fully aware of the economic necessity for adequate storage. How much *more* cognizant are today's engineers with their vastly increased problems — and how much better are their plans translated into reality. For example, Horton Steel, Canada's largest designing, fabricating and erecting company of steel vessels and steel plate structures, has Dominion-wide facilities in the form of fully equipped fabricating plants, erection and sales offices — plus pioneering records in welding techniques — to change plans into profitable production.

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● BRANCH NEWS

It was essential that in the adoption of confederation nothing be destroyed, but rather a step forward be taken.

In thanking the president, Al Brookes remarked that his visit served to demonstrate that the busiest man took on greater responsibilities. Mr. Brooks wished all concerned a very successful convention at Banff.

Marking the visit, silver replicas of "Earnie", the Cominco mascot elephant were presented to President and Mrs. McKillop by W. G. Small, Branch chairman.

MONTREAL

G. M. BOISSONNEAULT, JR.E.I.C.,
Secretary-treasurer

Summer Activities

The Branch membership may have the impression that the Branch suspends all activity after the final papers are presented in April. Such, however, is not the case. The executive has been extremely busy in both Branch and headquarters activities.

Evening Education Studied

At the last meeting of the executive, held on June 26, 1957, the committee on evening education presented a report of its activities. Considerable information has been gathered and studied with respect to the practice in other countries where degrees in engineering are attainable through evening courses. Preliminary talks have been held with the universities in the Montreal area to determine their views on this question. The committee now proposes to send out questionnaires to employers of engineers and to those employees who might be interested in such courses.

Program Committee

The program committee has been busy planning fall activities. Dates and topics have already been arranged for 28 papers and plant tours beginning October 1, 1957. The new program committee is now completed. Its members are, chairman, R. J. Kane, of the Dominion Bridge Company; secretary, J. P. Dagenais, also of Dominion Bridge. G. H. Hoganson, of the Canadian National Railway is chairman of the special section. The chemical section chairman is H. F. Bertram of the Great Lakes Carbon Corporation. Alec Ramsey, of the Northern Electric Company and Professor R. Edis of McGill University were elected chairmen of the electrical and mechanical sections and mechanical sections respectively.

H. J. T. Patterson, of Dominion Structural Steel heads the civil section as chairman. W. B. White of the Canadian National Railways was elected chairman of transportation. J. M. Weintraub, of the Northern Electric Company will direct the management section as chairman. S. A. Marcotte also of the Northern Electric Company has been elected junior section chairman.

The program committee has re-organized its committeeman's guide for program sponsors, meeting chairman, as well as for its own committee members. In addition, an appendix has been prepared by D. Denovan, chairman of the Branch publicity committee, in order to gain publicity through the local press, radio and television.

Professional Development

The Montreal Branch is pleased to announce that it is following the lead taken

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Eighth Annual Engineers' Ball

of the

HAMILTON BRANCH

OCTOBER 11, 1957

at

Fischer's Hotel, Hamilton, Ont.

Burgundy and Century Rooms

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by many branches across the country in setting up Professional Development Courses. Under the sponsorship of the Junior Section and chairmanship of R. B. Walker, Jr.E.I.C., of B. A. Shawinigan Limited, a seminar on professional development has been organized to begin this fall. A complete program of lectures and topics has been laid out for twenty lectures. By means of a questionnaire, more than 150 Junior members have indicated their interest in taking this course. At present the Committee is busy lining up top flight instructors and seminar leaders to head these lectures.

Entertainment Committee

The entertainment committees of both Senior and Junior Sections have been busy planning dates and making arrangements for the Annual Junior Section Dance, the Junior Section Golf Day, the Annual Senior-Junior Oyster Party and the Branch Annual Dance.

E.I.C. Annual Meeting

The Montreal Branch was well represented at the Annual General Meeting of the Institute, held in Banff in June. Many of the Branch councillors attended the meetings of Council, while several Branch Members attached to the staff of local universities attended the conference on education. The Branch was represented at the Branch Officers' conference by its secretary-treasurer, G. M. Boissonneault. All who attended the Banff meetings were lavish in their admiration of the success of the meeting, of the scenery and not the least, of the hospitality of the members of the Calgary Branch and their great musical hit review, "The Pipeline Review".

Appointment of J. E. Leo Roy

The Branch is fortunate to have as its chairman for 1957 Leo Roy, recently named general manager of the Quebec Hydro-Electric Commission. Mr. Roy, who was also secretary-treasurer of the Montreal Branch is a past-president of the Corporation of Professional Engineers of Quebec. He also represents that body on the Council of the E.I.C.

MONCTON

Engineers' Wives Meet

The annual meeting and dinner of the Engineers' Wives Association of the Moncton Branch was held on May 30, 1957 at Magnetic Hill Inn. The president, Mrs. M. F. K. Leighton presided. Thirty-five members and guests attended.

The annual report and financial statement was presented by the secretary-treasurer, Mrs. V. C. Blackett, and on motion approved. Mrs. H. L. Purdy, reporting for the nominating committee, submitted a slate of officers for the coming season. These officers are: honorary president, Mrs. G. E. Franklin; president, Mrs. M. F. K. Leighton; vice president, Mrs. G. A. Peck; secretary treasurer, Mrs. V. C. Blackett; social convener, Mrs. R. P. Puddester.

Mrs. Leighton, as president, invited members, their husbands and children to a picnic at her shore cottage on Saturday, June 22.

Following the dinner and business meeting, the evening was spent in playing bridge and other games.

VANCOUVER

A. D. CRONK, JR.E.I.C.,
Secretary

Economic Future Studied

Following the business meeting and presentation of reports at the annual meeting, Dr. John J. Deutsch, head of the department of economics and political science at U.B.C., spoke on British Columbia's Economic Future". Dr. Deutsch was formerly assistant deputy minister of finance at Ottawa before going to U.B.C. He has served on several economic Royal Commissions. The speaker reviewed the history of B.C.'s economic development and explained that the present dependence on forest products and export of other raw materials makes the economy very vulnerable to depressed world markets. Dr. Deutsch foresees a more balanced economy in prospect for the province with the expanding population, development of secondary industries and the tremendous potential markets in Asia facing B.C. across the Pacific.

Chris Webb thanked the speaker for his interesting address and another successful annual meeting of the Branch was concluded.

Structural Section Elections

At the annual meeting of the structural section the following officers were elected; Chairman, Gordon Ellis; vice chairman, Peter Jones; secretary-treasurer, Steve Faliszewski.

The meeting was addressed by O. [illegible] Bentzen who gave an interesting address accompanied by slides on "Some Methods of Tunnel Construction Leading up [illegible] the Deas Island Tunnel".

E.I.C. Annual Meeting
1958
Quebec City
Chateau Frontenac
May 21, 22, 23.

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News of Other Societies

Canadian Gas Association Meets at Jasper

The annual meeting of the Canadian Gas Association was held at Jasper, Alta., on June 24-26, 1957, with 450 delegates in attendance.

Delegates heard that the year just concluded was possibly the most active in the history of the Association. Highlighting the report of the Board of Directors was the establishment of the Canadian Gas Approvals program under which the association is empowered to undertake the testing, through approved agencies, of all gas burning equipment and appliances. The program provides for issuing seals of approval on all equipment and appliances manufactured and distributed for sale in Canada. Such authority has already been given in B.C. and Ontario, while other provinces are recognizing the C.G.A. seal of approval.

President-elect H. C. Darroch, promised that during his term of office he would dedicate himself to the task of promoting the development of the Canadian gas industry in all of its activities to the end that it may serve to the fullest extent the best interests of the public. Probably Canada's greatest need, he said, "is for secondary industries to create employment. Natural gas will develop such industries primarily as low-cost flexible energy source, but also from its many by-products-chemicals, new processes, new products, liquid propane and the materials and labour required by pipe lines and distribution systems."

Today, he reported, C.G.A. represented nearly 500 gas utilities, pipeline companies and gas appliance and equipment manufacturers across the country. The industry had nearly a million consumers in some 450 municipalities across Canada, and it had boomed forth as a billion dollar industry. About 65 per cent of these consumers were served by natural gas, and this percentage would increase annually. During 1955 gas sales had totalled nearly 134 billion cubic feet, representing a revenue of $76 million.

"Natural gas has been responsible for transforming Alberta from a province whose future was static to one which will soon be the pride and prototype of a new Canada," said the Honourable A. R. Patrick, Alberta's minister of Economic Affairs. Referring to the Trans-Canada Pipeline project, he noted that to date there had been more money spent on this development than on the St. Lawrence Seaway project.

President Dennis K. Yorath of Northwestern Utilities Limited, Edmonton, predicted a third pipeline to export natural gas from Alberta would be built within the next five years.

Natural gas, he felt, would not have any adverse effect upon electricity, but would affect sales of oil as a residential fuel. Although electricity to date would not heat buildings economically in subzero weather, he pointed out, natural gas was being used to generate electric power.

One of the main problems facing the gas industry today, he warned, was the manpower situation. He added that it would "become acute" over the next several months.

Nathan E. Tanner, chairman of the board, Trans Canada Pipelines Limited, told delegates that this country would be able to replace imported coal with natural gas. Such replacement in 1956 had resulted in a saving of about $40,000,000, he said. Ontario alone imported $75,000,000 worth of coal in 1955.

40th C.I.C. Conference Held at Vancouver

The Chemical Institute of Canada held its 40th annual conference at Vancouver on June 3 to 5, 1957. Technical sessions were held on the University of British Columbia campus, with a record number of 160 papers presented. These included a symposium on air pollution sponsored by the Chemical Engineering Division and a panel discussion by the Chemical Education Division on "What Can Be Done to Assist High School Chemical Education."

Dr. Osman J. Walker, head of the department of chemistry and director of the School of Graduate Studies, University of Alberta, was elected president succeeding Dr. C. B. Purves, the retiring president. Cecil E. Carson of Toronto, director, Imperial Oil Limited, general manager of Imperial Oil Refineries and vice - president, Interprovincial Pipeline Co., was elected vice-president. Twelve new councillors were elected and 18 new Fellows. Dr. Garnet T. Page announced his retirement, August 31st as general manager and managing editor, a post he had held since 1946. He was presented with a chest of silver by Dr. Purves as a token of his long and valued service to the C.I.C. and to the chemical industry.

The C.I.C. medal for 1957 was presented to H. G. Thode, president, Hamilton College, McMaster University, Hamilton, Ont. Made of the rare metal palladium supplied by the International Nickel Company of Canada, the medal is the highest scientific award of the Institute. The Montreal Medal was presented in absentia to Leon Lortie, director, extension department, University of Montreal, as a mark of distinction and honour to a Canadian who has made an outstanding contribution to the profession of chemistry or chemical engineering in Canada.

The Merck Lecture was presented by A. C. Neish, head, section of biochemistry and physiology of plants, Prairie Regional Laboratory, Saskatoon. These lectures are designed to bring distinguished scientists to address conference delegates. One of the featured speakers was J. H. Rushton, president, American Institute of Chemical Engineers. The title of his paper was "Chemical Engineering — Your Profession".

The Westman Memorial Lecture was presented by Joel H. Hildebrand, professor emeritus, University of California, Berkeley, Calif. Dr. Hildebrand, a noted educationalist, discussed university curricula and courses, pointing out that our high standard of living could not be maintained indefinitely on the basis of a low standard of intelligence or "planned mediocrity". He urged as counter measures: better standards of pay for teachers; recognition of the necessity for paying the prevailing wage as done in other fields of employment; allowing the experienced teacher to teach his own way; and minimizing non-teaching tasks.

Dean H. C. Gunning, faculty of applied science, University of British Columbia, was guest luncheon speaker on the second day of the conference. Discussing the boundaries between the practice of professional engineering and some of the professional sciences, and indeed between it and some other activities, he pointed out they were difficult to define, and continued to change with our rapid advance in technology. The part played by technical or scientific socie

ties or institutes was vitally important, he emphasized, whether linked or not with legal regulation of a profession. This was particularly true in regard to maintenance if that very vital factor in the life of us all,—professional competence. A true profession, he said, existed only as the people allow it to maintain its prerogatives, by reasons of confidence in its integrity and belief in its general beneficence.

Under the chairmanship of Dr. Morris Katz, the air pollution symposium consisted of 14 papers on methods of studying and correcting atmospheric pollution. Methods were described for treating vent gases from kraft pulp mills, ammonia oxidation plants, chlorine and caustic plants, oil refineries, and metallurgical plants. Reactions taking place in smog systems were considered. A description of proposed air pollution legislation for Ontario provoked considerable discussion.

Two invited papers and forty contributed papers were presented for the physical chemistry division program on varied subjects such as nuclear magnetic resonance spectrography; the increasing use of labelled atoms; effects of ionizing radiations on solids and liquids; and the use of scintillating gels. Dr. R. D. Heyding of National Research, Ottawa, described recent work on the structures of the arsenides of iron, cobalt and nickel.

C.I.C. Forms New Division

The new Chemical Economic Subject Division of the Chemical Institute of Canada will concentrate on the commercial and economic aspects of the Canadian Chemical and Chemical Process Industries, and will cater to the needs of those engaged in or interested in development, finance, market research purchasing, sales, advertising, traffic and industrial relations.

An inaugural national meeting of the group is to be held at Montreal's Mount Royal Hotel on October 29, 1957, theme of which will be, "Canadian Chemical Industry — 1962."

Speakers and panels will focus attention on trends in the growth of this industry and its development during the next five years.

Keynote speaker will be Dr. J. R. Donald, O.B.E., a prime authority on the broader national and international ramifications of the Canadian Chemical Industry. President of J. T. Donald and Company (1956) Limited, Dr. Donald, was formerly the director-general of the chemicals and explosives production branch of the Department of Munitions and Supply and was one of the original members of the Joint War Production Board of the United States and Canada set up under the Hyde Park agreement by President Roosevelt. He is past president of the Canadian Chemical Association and of the Canadian Section of the Society of Chemical Industry, and holds numerous awards in recognition of his important contributions to the industry.

Panels will be led by noted specialists in their fields and the panel members, senior executives of the industry, will bring a wide diversity of talent and experience to bear on their subjects. The panel on development and finance will be chaired by C. R. Graham, director of economic and market research, J. T. Donald and Company (1956) Limited. D. M. Matheson, vice-president and general manager of Chemical Developments of Canada Limited, will lead the panel on purchasing and traffic. Dr. J. A. McCoubrey, manager of market development of North American Cyanamid, Limited, will co-ordinate the panel on sales.

Mutual problems of chemical industry sales and purchasing executives will be aired by G. T. Boomer, district sales manager, C.I.L., and W. D. Wright, general purchasing agent, of E. B. Eddy and Company, during the luncheon session.

Guest speaker at this national meeting of the Chemical Economics Subject Division of the Canadian Institute of Chemistry will be Nik Cavell. Administrator of the Colombo Plan Administration in Canada, known as the International Economic and Technical Cooperation Division of the Department of Trade and Commerce, Mr. Cavell was formerly managing director of Automatic Electric Company (England) and president of the company's affiliates in China and Japan. He subsequently established Automatic Electric (Canada) Limited, which with its manufacturing organization, Phillips Electrical Works Limited, was built into a very large enterprise. In 1951, he was asked by the Government of Canada to undertake the administration of Canada's participation in the Colombo Plan, and now travels extensively in South East Asia in the course of the Colombo Plan work. He will speak on the Colombo plan and the important contribution of his administration to the capital expenditure and technical assistance program which Canada is making under the Plan in South East Asia.

For meeting registration forms and further information on the chemical Economics Subject Division, please contact

J. R. Charlton, Esq.,
Canadian Resins and Chemicals Limited,
600 Dorchester Street West,
Montreal, P.Q.

CISC Annual Meeting

At the organization's 27th annual general meeting held at the renowned Seigniory Club at Montebello, Que., recently, George H. Crase, of Horton Steel Works Ltd., Toronto, retiring president emphasized that "The Canadian Institute of Steel Construction is becoming more and more a nationwide organization with an ever broadening influence for good practice in the structural steel and steel plate fabricating industries."

Mr. Crase said that the continued extraordinary demand for steel had given rise to difficulties during the year. In spite of enormous expansion programs the demand for steel had exceeded the capacity of the rolling mills and had resulted in delay and disappointment to some customers. Production was however, only 8 per cent less than in 1955-56.

Commenting on other activities of the Institute Mr. Crase said that during the past year a seminar on plastic theory of design was sponsored in co-operation with Queen's University and the Royal Military College. Attended by about one hundred engineers, the Institute paid the expenses of four representatives from universities to attend this seminar. Notes made during the seminar were incorporated in one of C.I.S.C.'s special bulletins and issued to about 400 engineers.

Officers Elected

The election of R. M. Robertson, manager of operations for Dominion Bridge Company Limited, Montreal, as president of C.I.S.C. was followed by that of three vice-presidents. They are W. A. Hepburn, vice-president of J. T. Hepburn Limited, Toronto; W. J. Disher, president of Disher Steel Construction Company Limited, Toronto, and R. C. Pearse vice-president and manager of the Ontario division of Dominion Bridge Company Limited.

Honorary treasurer is G. E. Ellsworth president of the Toronto Iron Works Limited, Toronto.

Regional vice - presidents elected were; for the Atlantic region, John Reed chief engineer of the St. John Drydock Company Limited, East St. John. In Quebec province, R. S. Eadie, vice-president and general manager of the Eastern division, Dominion Bridge Company Limited, Montreal, has been elected, while F. P. Flett, district manager of Truscon Steel Company of Canada Limited, Toronto, will represent Ontario. Western representative is T. Bishop, manager of the Dominion Bridge Company Limited Calgary. For the Pacific region, E. H. Hartley, general manager of the Western Bridge and Steel Fabricators Limited Vancouver is representative.

Library Notes

Additions to the Institute Library

Reviews, Book Notes

Standards

BOOK REVIEW

NUCLEAR POWER YEAR BOOK AND BUYER'S GUIDE 1957/8

With the increasing importance of nuclear power and the lead which the United Kingdom is taking in its development for peaceful uses, the publication of this first edition of a yearbook devoted to the subject is indeed an important event.

The first section contains brief review articles recording current trends and thinking in many fields of applied atomic energy: nucleonic instrumentation; mining of uranium minerals; zirconium; future trends in fuel elements; neutron moderators for nuclear reactors; atomic energy and the law, etc.

The section on the world's atomic energy authorities gives details on atomic energy undertakings throughout the world, their organization, financial basis, governing bodies, projects, research facilities, educational arrangements and permanent officials.

Basic nuclear physics data is given in another section, and there is also a section on isotopes, their properties, applications and sources of supply.

Half the book is devoted to an alphabetical list of British companies engaged in the manufacture of machinery etc. used in the production of nuclear power, together with their overseas offices and representatives. There is a classified buyers' guide divided into two sections, the first listing material, plants, equipment and services for nuclear energy undertakings, and the second the instruments and equipment used in the laboratories, plant control rooms and in the field.

A Who's Who in British nuclear energy completes this most valuable book which is thumb indexed for easier reference. This company also issues a periodical on the subject, with the title, as one might expect, Nuclear Power. (Ed by William Davidson. London, Rowse Muir, 1957. 500p., $8.50.)

> Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.
>
> **LIBRARY HOURS**
>
> Monday to Friday
>
> 9 a.m. — 5 p.m.

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

*AMERICAN CIVIL ENGINEERING PRACTICE, VOLUME 3

The third volume of this important new reference work presents the fundamental principles, procedures, and data for the following section headings: theory of structures; masonry and plain concrete; reinforced concrete, including detailed design of members; prestessed concrete structures; footings, piers, and abutments; retaining walls; steel and reinforced-concrete bridges; steel towers, tanks, bins, etc.; concrete chimneys, silos, tanks etc; timber structures: steel-framed and reinforced-concrete buildings, including structural planning, earthquake-resistant design. (Ed. by R. W. Abbett. New York, Wiley, 1957. Various paging, $15.00.)

*THE ANALYSIS OF ENGINEERING STRUCTURES, 3RD ED.

As in previous editions the primary object is to present to the student of engineering a general outline of the theories upon which the design of structures is based. Some items and materials dealt with include: straight and curved beams; elastic bodies; redundant frames; reinforced concrete; the suspension bridge; influence lines; the voussoir arch; steel framed buildings; masonry dams; retaining structures; and plastic theory. (By A. J. S. Pippard and J. F. Baker. Toronto, Macmillan, 1957. 564p. $10.25.)

ANGER'S DIGEST OF CANADIAN LAW, 17TH ED.

The courts maintain that ignorance o the law is no excuse for break ing it, and although this latest editio of the Digest of Canadian commercia law is not intended as a substitute fo legal advice, it does give a review o the law for ready reference.

The book covers the law relating to wide variety of topics in non-technica language, and includes: agency; ban ruptcy; banks, banking and cheque bills; contracts; copyright and patent insurance; mortgages; partnerships; prop erty; trade marks; wills and descent property; in fact every subject covere by Provincial or Federal business la It does not attempt to cover criminal la municipal statutes, or taxation.

The revisions in the Bank Act are i corporated in this edition, as are amen ments in various Provincial laws, a the chapters on copyright, trade mar and patents have been completely r vised.

Statutes and legal conditions va from Province to Province, and as th volume points out the difference a similarities in the various Provinces, will be particularly valuable to firms a individuals with business connectic outside their own area.

This book should find a place every businessman's desk, and in ev library. It presents a clear picture Canadian commercial law, and answ the question asked so often "What the law on that?" (Ed. by F. R. Hu Toronto, Cartwright, 1957. 535 $8.00.)

LIBRARY NOTES

APPLIED RELIABILITY. PROCEEDINGS OF THE FIRST AND SECOND RETMA SYMPOSIA

That electronic reliability has developed into an "applied" science was borne out by the papers presented at these Symposia held in 1956 and 1957.

The general subjects covered at the first symposium included mechanical reliability, information feedback, field failure feedback, and component evaluation and usage. The principle objectives of the papers are to describe methods of reliability evaluation, improvement and prediction.

In addition to the papers, there is included in this book a supplement entitled "A general guide for technical reporting of electronic systems reliability measurements," which was prepared by members of the Systems Reliability Analysis Task Group of RETMA'S Electronic Applications Committee (Reliability).

The fifteen papers included in the second symposium on electronic equipment are broadly classified in the following sections: selection and use of components; principles and techniques of mechanical design; measurement and proof of mature design; case histories of specific pieces of equipment. These papers deal not only with the basic factors for reliability in operation, but also with specialized aspects of construction and operational conditions, and with failure prediction techniques. (New York, Engineering Publishers, 1956-7. $5.00 each.)

*BORON, CALCIUM, COLUMBIUM, AND ZIRCONIUM IN IRON AND STEEL

The fourth volume of the Alloys of Iron New Monograph series brings together essential information on boron, calcium, columbium (plus tantalum), and zirconium as alloying metals in iron and steel. The material gathered here has been culled from the technical literature of the world, from material scattered through journals and books in many languages and is presented in English. There is an excellent bibliography, name indexes, and a thorough subject index. (By R. A. Grange and others. New York, Wiley, 1957. 533p., $14.00.)

*BRITTLE BEHAVIOR OF ENGINEERING STRUCTURES

Prompted by the failures in welded steel merchant ships in 1942-43, research in this field was instituted and widened to include all steel plate structures. This volume summarizes the available information, covering the following: fundamental properties and fracture theories; test methods and interpretation of results; influence of chemical composition and manufacturing practice; effects of welding composition variations; residual stresses; design aspects; and report on individual service failures. This study was prepared for the Ship Structure Committee under the general direction of the Committee on Ship Steel of the National Reearch Council. (By E. R. Parker. New York, Wiley, 1957. 323p., $6.00.)

COLOR TELEVISION STANDARDS

Selected papers and records of the National Television System Committee make up this book. It shows the development of colour television, lists and discusses NTSC standards, includes material and discussion concerning the rerequirements of human vision in relation to colour television, and deals fully with the colour-video signal and the colour-synchronization signal. There is also a discussion of tests on both black and white and colour receivers; and finally a chapter on the actual transmission processes and equipment. A glossary of terms is included. (By D. G. Fink. Toronto, McGraw-Hill, 1955. 520p., $8.50.)

CONCRETE REINFORCING STEEL INSTITUTE DESIGN HANDBOOK

The designs in this revised and enlarged edition are based on the latest American Concrete Institute Building Code . . . for Reinforced Concrete, and are particularly for preliminary estimating, establishing sizes and clearances and comparing different types of construction.

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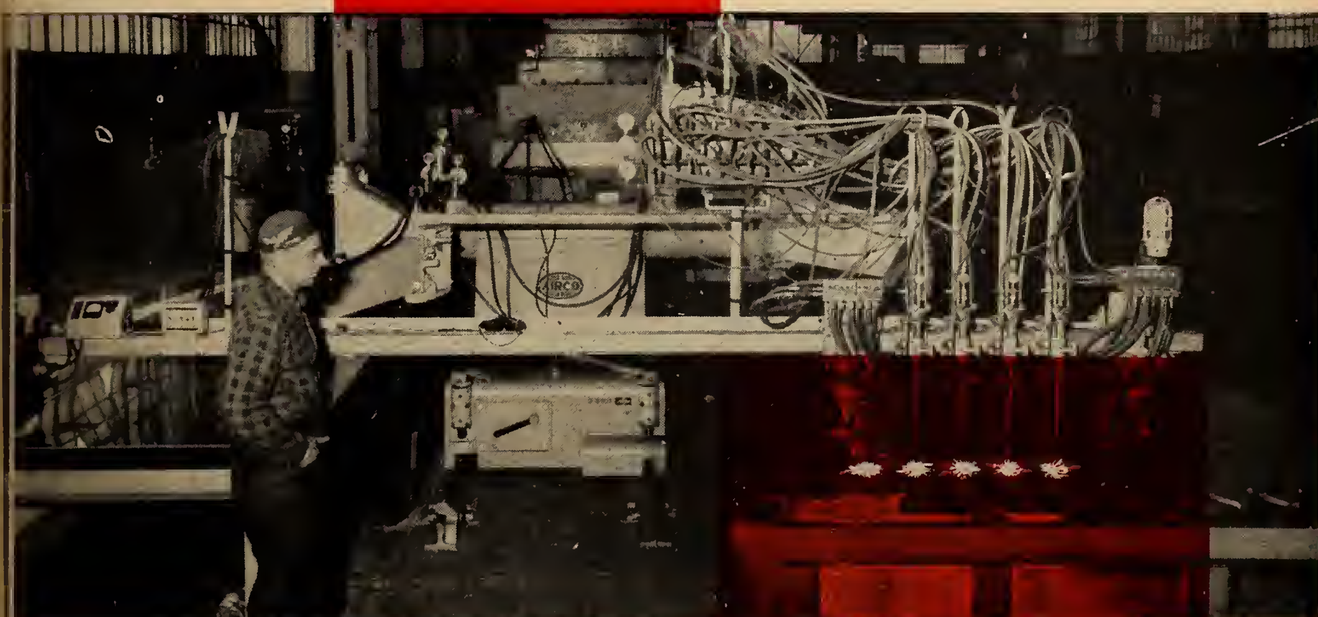

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Most of the material is presented in tabular form, and covers: reinforcing bars; design formulas, methods, data, notes and hints; safe load tables and A.S.T.M. specifications. New data in this edition includes: design curves for solid slabs, concrete joists and beams; stair slabs, pits and precast lintels; "waffle" or dome flat slabs; ultimate strength design summary; fire resistance in concrete floors; load tests on soil, grain elevators.

This edition should prove even more useful than the previous one. (Ed. by R. C. Reese. Chicago, Concrete Reinforcing Steel Institute, 1957. 447p., $6.00.)

*DEOXIDATION OF STEEL: A MEMORIAL VOLUME TO C. H. HERTY, JR.

A collection of selected papers by Dr. C. H. Herty, Jr., emphasizing his most significant work on the physical chemistry of steelmaking. The papers, not generally obtainable today, deal with elimination of metalloids, solubility of iron oxide in iron, deoxidation with silicon and aluminum, the control of ixide in the open hearth process, and with other problems affecting refining reactions and the quality of steel. The volume includes a biographical sketch, a list of his publications and patents, a chapter on the significance of Herty's work, and short biographical sketches of 37 of his co-workers on the Physical Chemistry of Steel Making project. (New York, National Open Hearth Committee American Mining, Metallurgical and Petroleum Engineers, 1957. Various pagings, $10.00.)

*DESIGNING FOR PRODUCTION

Primarily a textbook for engineering and technical students presenting fundamentals underlying the design and manufacture of a product that will be functionally sound, marketable, and profitable. Ferrous, non-ferrous, plastics, rubber and synthetic rubber materials are described from the designers' viewpoint. Manufacturing information includes metal forming and shaping, metal cutting, joining processes, finishing processes, and packaging. (By E. N. Baldwin and B. W. Niebel. Illinois, R. D. Irwin, Inc., 1957. 645p., $8.40.)

*ELECTRIC CIRCUITS AND MACHINES, 2ND ED.

The general scope of this book includes the major subjects of circuits, machines, electronics, and instruments, with considerable stress on single-phase circuit theory. In the revision, sections have been added on transistors, crystal diodes, and the resistance strain gage, and an appendix on the magnetic circuit has been included. Also, numerous problems have been added and some of the older ones replaced or revised. (By B. L. Robertson and L. J. Black. Toronto, Van Nostrand, 1957. 456p. $7.25.)

*ELECTRICITY AND MAGNETISM

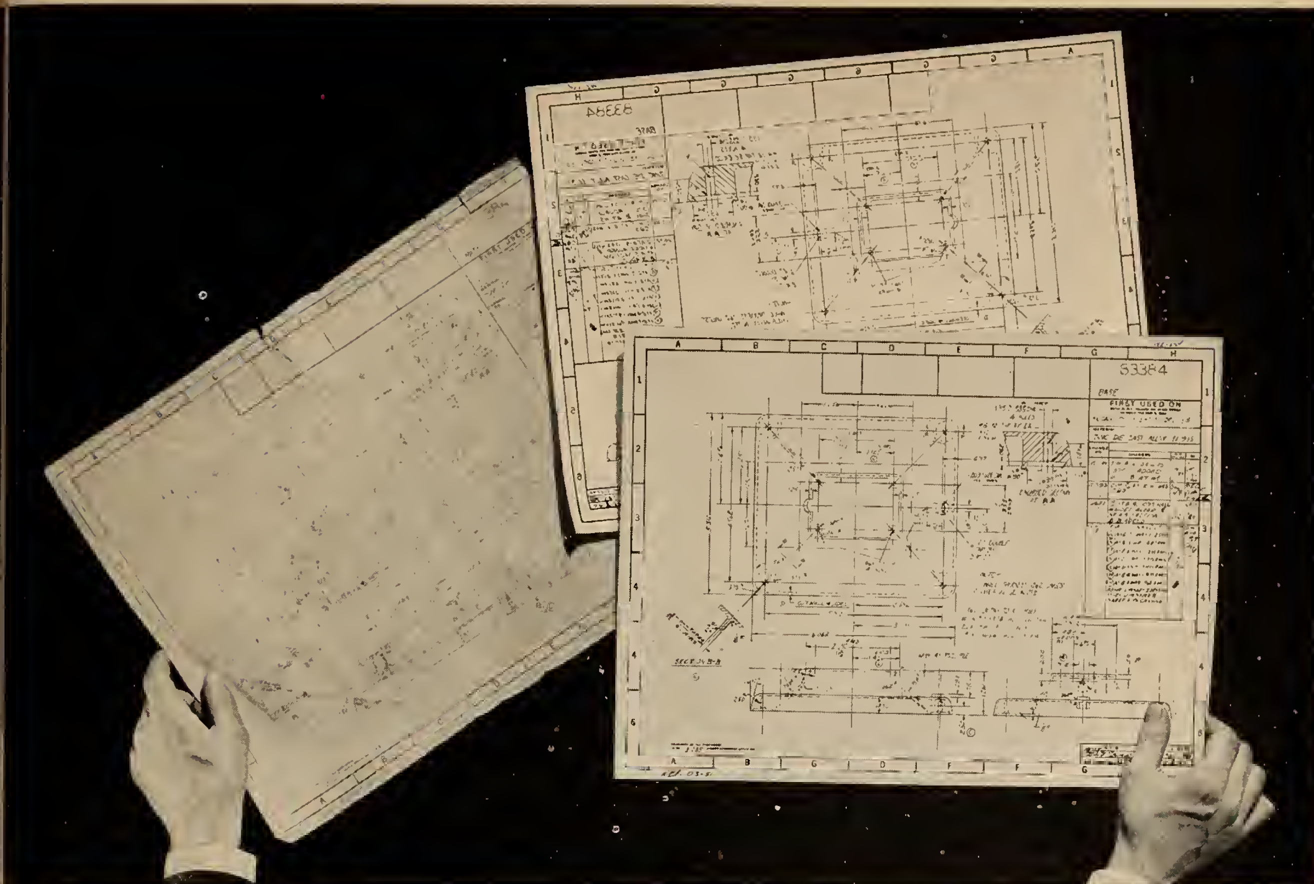
This text gives an up-to-date account of the principles and experimental aspects of electricity and magnetism, together with an elementary account of the underlying atomic theory. The four main sections are: 1) electrostatics, electric currents and magnetic fields, magneto-statics, and magnetic effects; 2) alternating current theory and electromagnetic waves, including filters, lines and waveguides; 3) electromagnetic machinery, thermionic vacuum tubes and noise; 4) theory of dielectrics and dispersion, the band theory of metals and semiconductors, paramagnetism and ferromagnetism, and a final chapter on nuclear magnetic resonance and recent R. F. measurements of the fundamental constants. (By B. I. Bleaney and B. Bleaney. Toronto, Oxford University Press, 1957. 676p., $9.50.)

ELEMENTARY SOIL AND WATER ENGINEERING

Intended for students in agriculture and related fields having no previous engineering training, this book emphasizes the engineering aspects of soil and water conservation, and also considers the agronomic and economic aspects of the subject.

In an introductory chapter the authors discuss the future requirements of land and water of a growing population, while the next four chapters deal with simple surveying and its application to farm problems. The remainder of the book covers the various conservation engineering problems found on the farm, including soil erosion and its control by contouring etc., drainage, land clearing and irrigation.

The book includes numerous diagrams and references to further reading. The information given is applicable to all parts of the United States, and much of it had not been previously available except from the Soil Conservation Service. (By G. O. Schwab and others. New York, Wiley, 1957. 296p., $6.25.)



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LIBRARY NOTES

*ENGINEERING ELECTRONICS

Devoted to the non-radio areas of electronics — signals, methods of control, instrumentation, etc. — this book emphasizes the underlying principles and basic circuits applicable to various devices and equipment. The first three chapters are a survey of fundamentals; the remaining chapters take up specific devices and circuits such as amplifiers, switching circuits, filters, oscillators, transistors, photoelectric devices, and servomechanisms. The book is intended as a text for seniors and for use by practicing engineers. (By J. D. Ryder. Toronto, McGraw-Hill, 1957. 666p., $11.40.)

FRASER'S CANADIAN TRADE DIRECTORY, 1957

This is the 44th edition of this most valuable directory to Canadian trade and industry. It gives comprehensive coverage to all aspects of Canadian trade, including a classified directory of manufacturers with index to classification; a market data section which covers chambers of commerce, public utilities companies, banks, Canadian trade commissioners, a directory of the Department of Trade and Commerce, countries served by foreign trade, and lists, alphabetically under province, cities and towns of population 1,500 and over; an alphabetical list of over 12,500 Canadian manufacturers; a list of trade names giving manufacturers; and a guide to foreign manufacturers with their Canadian agents. (Montreal, Fraser's, 1957. 1848p., $10.00.)

*GEOLOGICAL FIELD METHODS

For the inexperienced man in the field, this manual contains, in addition to the major outlines of geologic field work, hints and help on the minor aspects of methods and procedures which the author, from his long experience, has found most often needed in carrying out assignments. There is information on the organization of field work, field mapping, topography, and areal geology, mineral exploration, subsurface methods and a section on living and working out of doors. (By J. W. Low. New York, Harper, 1957. 489p., $6.00.)

GLOSSARY OF TERMS IN NUCLEAR SCIENCE AND TECHNOLOGY

This revised edition of a most useful Glossary contains many corrections, and amplification and clarification of earlier definitions.

The glossary which is arranged alphabetically, contains definitions of terms found in the fields of physics, reactor theory, reactor engineering, chemistry, chemical engineering, biophysics and radiobiology, instrumentation, isotopes separation and metallurgy.

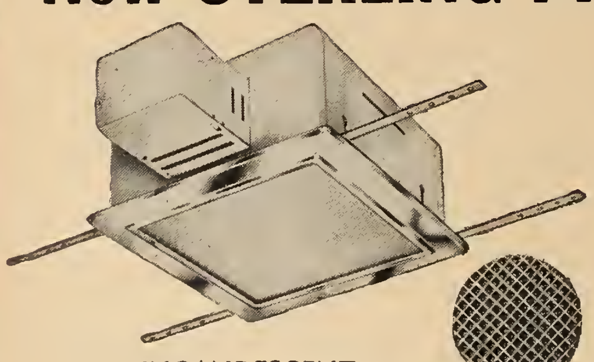
The ASME Nuclear Energy Glossary Committee and the National Research Council (U.S.) collaborated in the compilation of this work. (New York, American Society of Mechanical Engineers, 1957. 188p., $5.00.)

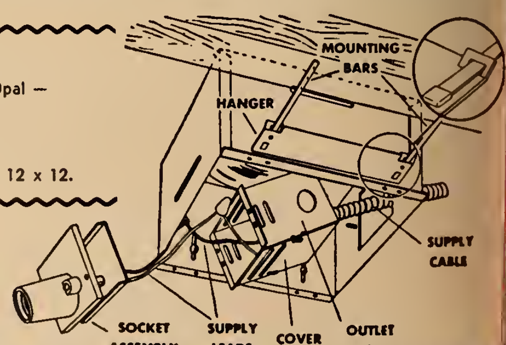
*HEAT TRANSFER AND FLUID MECHANICS INSTITUTE, 1957. PREPRINTS OF PAPERS

A wide range of subject matter is covered by the twenty-one papers included in this volume: shock waves; instability of bubbles; liquid drop section on surfaces; boundary layer problems in fluid flow; heat transfer under various conditions; flames and ignition; chemical kinetics of air at high temperatures; mass transfer by sublimation; several specialized treatments of turbulence and other aspects of fluid flow. (Stanford, University Press, 1957. 439p., $8.50.)

HIGH VOLTAGE SYMPOSIUM 1956. PROCEEDINGS

The publication of the Proceedings of this most timely symposium held by the National Research Council will be welcomed by all those connected with Canadian electrical utilities and the electrical industry. The St. Lawrence River represents almost the last source of hydroelectric power located close to load centers, and the development of more distance sources is dependent on cheap transmission, which means large load and very high voltage lines, and possibly direct current.





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This problem has been largely solved in Sweden, and four of the papers presented at the symposium were given by two Swedish engineers. The remaining sixteen papers were nearly all by Canadians, from both industry and the National Research Council.

The general topics covered were: breakdown and insulation problems; high voltage transmission; impulse measuring and testing; and corona and radio noise. Most of the papers include bibliographies, and there is also a list of N.R.C. publications on high voltage problems. (Ottawa, National Research Council, 1957. Irreg. paging, $1.00 while available.)

*HYGROMETRY

The measurement and control of humidity in industrial processes is becoming increasingly important. This book is a thorough survey of the scientific principles of practically every known type of hygrometer: frost point, dew point, condensation, hair, diffusion, electrolytic, gravimetric, etc. Also treated are a number of related topics such as the vapor pressure of water and ice, the vapor pressure of solutions, and the moisture content of highly compressed permanent gases. (By H. Spencer-Gregory and E. Rourke. London, Crosby Lockwood, 1957. 254p., 36/-.)

INDUSTRIAL RECTIFYING TUBES

The thirteenth in a series on electronic tubes to be published by Philips, this volume covers industrial rectifying tubes which are used to convert alternating current into direct current. The operation, construction and application of hot-cathode gas-filled rectifying tubes in battery chargers, power rectifiers and d.c. arc welders are discussed.

Technical data is given for eighteen different rectifier tubes, and a chart is included to help in the selection of tubes for a particular design. (By members of Philips Electron Tube Division. Eindhoven, Philips, 1957. 116p., $2.15.)

*INSTRUMENT TECHNOLOGY, VOLUME 3. TELEMETERING AND AUTOMATIC CONTROL

The present volume in this series deals in a brief section with pneumatic and electrical telemetering systems, and in more detail with the instruments and mechanisms for automatic control of processes. As in previous volumes basic principles are discussed before the actual instruments, and the instruments are classified according to the physical principle upon which they are based. (By E. B. Jones. Toronto, Butterworth, 1957. 198p., $8.00.)

INTRODUCTION TO THE CATHODE RAY OSCILLOSCOPE

Some cathode ray oscilloscopes are designed for specific applications in scientific or industrial research, but many are used for testing, inspection etc. in both electrical and mechanical engineering. It is for the users of the oscilloscopes in this connection that this book is written, as naturally they often have little knowledge of electronics.

The author covers the subject under the following headings: the cathode ray tube; the time base; amplifiers for vertical deflection; pickups for converting non-electrical phenomena into electrical magnitudes; power supply for cathode ray oscilloscopes; practical applications of the oscilloscope; standard cathode ray tubes for oscillography; and some complete oscilloscope circuits. (Harley Carter. Eindhoven, Philips, 1957. 95p., $1.95.)

*LINEAR PROGRAMMING; AN EXPLANATION OF THE SIMPLEX ALGORITHM

Linear programming may be described as a mathematical technique for determining the most effective course of action when a situation is governed by many known variables and conditions. In this small book a simplified technique is presented which is applicable to a great many engineering and management problems. A number of concrete examples, chiefly from production engineering, are here worked out, and mention is made of other books, on refinery problems for example, for which this book is a useful introduction. (By D. U. Greenwald. New York, Ronald, 1957. 75p., $3.00.)

LIBRARY NOTES

LOCATION AND SPACE ECONOMY

Although not intended primarily for engineers, all those concerned with the location of industry should find this an interesting and useful book.

The author, a professor of economics, presents a "general theory relating to industrial location, market areas, land use, trade, and urban structure." After an historical introduction expounding the location and regional problem, and a chapter clarifying some general theories of location and space economy, in the remaining chapters the author considers various factors: transport, labour, and market and supply areas. He also considers urban land-use and the location of agriculture, the basic interrelation of location and trade theory and gives a mathematical formulation for the aspects of general location theory.

There are many bibliographic footnotes, and a detailed index. (By Walter Isard. New York, Wiley, Cambridge, M.I.T., 1956. 350p., $8.75.)

METAL INDUSTRY HANDBOOK AND DIRECTORY, 1957

This is an annual, in its 46th year of publication, giving comprehensive coverage to the non-ferrous metals industry. It is arranged in four sections, the first giving the general properties of the different metals and alloys, and including a list of British standard specifications for non-ferrous metals and alloys as well as aircraft material, D. T. D., and admiralty specifications. Section two gives general data and tables relating to metals and metal products. Section three covers electroplating and allied processes and includes related tables. The last section is a directory of the British metal industry, including a list of trade names and their manufacturers, a directory of trade associations and technical institutes, a classified guide to metals and metal products giving names of producer, and an alphabetical list of firms with their addresses and telephone numbers. (London, Iliffe, Toronto, British Book Service, 1957. 536p., $3.25.)

METALLURGICAL PROGRESS—3

This collection of seven articles reprinted from IRON AND STEEL covers the metallurgy of, and metallurgical processes connected with, iron and steel. It includes articles on refractories, foundry practice, non-destructive testing methods, and flake graphite cast irons. There are comprehensive bibliographies included at the end of each article. (London, Iliffe, Toronto, British Book Service, 1957. 88p., $1.25.)

NUCLEAR ENGINEERING

Written by twelve experts in different fields of engineering and science, the purpose of this book is to outline the basic principles involved in the design of nuclear reactor cores and power plants, and to show the engineer the application of his particular field to nuclear power plant design.

Topics covered are: nuclear particles; nuclear physics; particle detection; basic concepts of radiation protection; elementary reactor physics; shielding of power reactors; flow of fluids; heat removal; metallurgy of uranium and uranium alloys; thermal-stress analysis and mechanical design; instrumentation and control; power generation; nuclear-reactor types; legal aspects of nuclear power.

Although intended as a graduate text for engineers and physicists, this volume contains such a wealth of information that it can be used as a reference book for those already in the field. It is a valuable addition to the literature on the subject. (Ed. by C. F. Bonilla. Toronto, McGraw - Hill, 1957. 850p., $15.00.)

*NUCLEAR REACTOR PHYSICS

Prepared for use by the graduate student in science or engineering and the design engineer in the nuclear energy field, this book discusses the physical concepts and calculation methods involved in the analysis of the behaviour of an assembly of fissionable material. The principal emphasis is on three major topics: the distributions in energy and space of neutron flux, the determination of the critical amount of fission-

able material, and the transient behaviour and control of the reactor as a heat source. (By R. L. Murray. Englewood Cliffs, N.J., Prentice-Hall, 1957. 317p., $10.00.)

°RAHMENFORMELN, 12TH ED.

A design manual presenting explicit rigid-frame formulas for single-panel frames which occur in practical reinforced-concrete, steel, and timber construction. It contains separate treatments of 114 rigid-frame shapes illustrated by 1578 figures covering a wide range of cases. General and special load conditions are dealt with, including temperature changes, and an explanatory introduction is provided. Eleven obsolete frames have been replaced by new shapes in this edition. An English translation exists of the previous edition of this highly useful reference work. (By Adolf Klehnlogel. Berlin, Ernst, 1957. 460p., DM 52.00.)

°RECENT ADVANCES IN SCIENCE. (PHYSICS AND APPLIED MATHEMATICS)

Twelve lectures, by acknowledged experts, designed to convey to non-specialists the basic ideas in such areas of science as cryogenics, ferromagnetism, microwave spectroscopy, operations research, and transistor physics. The lectures were delivered at a symposium held at New York University in 1954. (Edited by M. H. Shamos and G. M. Murphy. New York, Interscience Publishers, 1956. 384p. $7.50.)

RELIGIOUS BUILDINGS FOR TODAY

This is a collection of outstanding contemporary religious buildings. There are excellent photographs, both interior and exterior of synagogues, churches and chapels, with brief text. In each case a floor plan of the building is shown as well as several diagrams of structural details and photographs of windows, sculpture, ornamentation, etc. There are also brief essays included on worship and the arts from the different denominational points of view. The book should prove both interesting and stimulating to anyone interested in church architecture. (Ed. by J. K. Shear. New York, Dodge, 1957. 183p., $6.75.)

TECHNICAL DRAWING PART I

A basic introduction to the subject of technical drawing intended for students in technical schools, this volume covers such topics as straight lines, use of the compass, division of lines, drawing of solids, interpretation of drawings, sectional views, isometric drawings and freehand sketching.

Parts 11 and 111 to be published later will deal with practical geometry and the techniques of engineering drawing. (By W. Abbott. London, Blackie, 1957. 70p., 7/6.)

TECHNICAL BULLETINS AND PAMPHLETS RECEIVED

Canadian Arctic

The awakening North. Montreal, Distillers Corporation-Seagrams Ltd., 1957.

A report on sea ice conditions in the eastern Arctic, summer 1956. Ottawa, Dept. of Mines and Technical Surveys —Geographical Branch, 1957. 50 cents.

Electrical Engineering

The Electrical Research Association. 36th Annual report. 1956

The Electrical Research Association. Technical reports:—C/T115 — Wind data related to the generation of electricity by wind power. J. R. Tagg. G/T304 — The effect of series resistance on the ignition of methane-air gas mixtures by capacitive discharges. H. G. Riddlestone. L/T332 — Unified treatment of linear systems. I. H. Pelzer. L/T333 — The structure and properties of cadmium titanate and sodium tantalate. J. L. Miles. L/T335 — The mechanism of uniform field breakdown in hydrogen. A. Wilkes. L/T336 — Life-testing of impregnated paper capacitors: variability of results. H. F. Church. L/T337 — Oscillations of dielectrics and plasma. H. Pelzer. L/T338 — Polarization of the continuous spectrum in a gas discharge. B. V. Paranjape. L/T342 — On the polaron rest energy and effective mass. G. R. Allcock. S/T78 — Surge recording at

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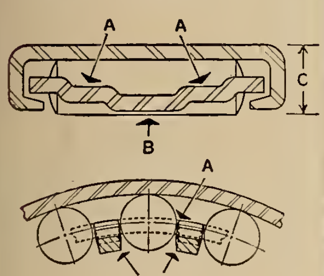

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● LIBRARY NOTES

High Street (Manchester) 33 kV substation. E. L. White. S/T82 — Surge recording at Portobello 132 kV substation. E. L. White. U/T135 — Oscillographic observation of short duration arcs between separating platinum and palladium contacts. J. Riddlestone. Z/T106.— An analysis of toothripple phenomena in smooth laminated pole-shoes. H. Bondi and K. C. Mukherji.

TV picture tube chassis guide. Rider Laboratory staff. New York, Rider, 1957. $1.35.

Engineers

Professional income of engineers 1956. Engineers Joint Council 1957. $1.50.

What is troubling industry's engineers. Princeton, Opinion Research Corporation, 1956.

Highway Engineering

Durability of concrete: physical aspects. (U.S. Highway Research Board, Bibliog. 20.)

Effect of de-icing chlorides on vehicles and pavements. (U.S. Highway Research Board. Bul. 150)

Rubber in roads. Natural Rubber Bureau, Washington, 1957.

Labour

The shorter work week. (bibiliog.) Princeton Univ., Industrial Relations Section, 1957.

Workers abroad. UNESCO, 1957.

Lubrication

Friction tests of extreme bearing pressure (E.P.) lubricants. A. Sonntag. Stamford, Alpha Molykote Corp., 1957. (Lubrication newsletter, v.2, no. 1)

St. Lawrence Seaway

The St. Lawrence Seaway under construction. Ottawa, St. Lawrence Seaway Acthority, 1957. $2.00.

Silicones

The industrial chemistry, properties, and application of silicones. C. E. Reed. Philadelphia, A.S.T.M., 1956.

Steel

Arc welds in mild steel — production and inspection. C. R. Harman. London, British Welding Research Association, 1956. 2/6.

The Cold Rolled Sections Association Manual of technical reference. Birmingham, The Assoc., 1955. 42/-.

Town Planning

Rosetown plans its future. Regina, Dept. of Municipal Affairs, 1957. $1.50

Sewerage service for urban housing in Canada. Central Mortgage and Housing Corp., 1957.

Miscellaneous

British Engineers' Association classified handbook of members. London, The Assoc., 1957. 21/-

G.E.C. Simon-Carves atomic energy group; administration and organisation. Erith. Kent.

Pressure treatment for lasting timber construction. Ottawa, Canadian Institute of Timber Construction, 1957.

Symposium on tension testing of nonmetallic materials. Philadelphia, A.S.T.M., 1956. $2.00. (S.T.P. no. 194)

STANDARDS RECEIVED

A.S.T.M. Standards, American Society for Testing Materials, 1916 Race St., Philadelphia 3.

Standards on cement (with related information) 264 p., $3.00

Specifications for steel piping materials. 445 p., $4.50

British Standards, British Standards Institution, 2 Park St., London, W.1. Also available from the Canadian Standards Association.

B.S. 587: 1957 Motor starters and controllers. 8/-.

B.S. 1016: Part 1: 1957 methods for the analysis and testing of coal and coke. Part 1: Total moisture of coal 3/6.

B.S. 2846:1957—The reduction and presentation of experimental results. 10/-.

S. 122-Low nickel-chromium steel. (aircraft) 1/6.

lems. The selected applicants will be expected to participate in planning and conducting research projects, some of which will require experiments in flight. The work will be varied and interesting and will appeal to those who prefer to work in a small group closely associated with aircraft. It will in turn require an ability to originate ideas in both the experimental and theoretical fields. Candidates should have completed a post graduate course in aeronautical engineering (Ph.D, masters degree or its equivalent) Alternatively candidates from other sources, such as engineering physics, but with a strong interest in and familiarity with aeronautical subjects will be considered. Mechanical engineer: to assist with researches on aeronautical problems. The selected applicant will be expected to participate in planning and conducting research projects, some of which will require experiments in flight. The position requires an ability to design experimental equipment for airframes and power plants. Familiarity with turbine engines is desirable. Instrumentation engineer: to work on the design of instrumentation systems and on the design and development of special instruments for flight research purposes. Applicants should have a university degree in electrical engineering or engineering physics. All salaries commensurate with education and experience. File No. 6181-V.

UNIVERSITY OF ALBERTA, research appointment with rank of associate professor. Open September 1st for engineer with experience in transistor circuitry. The appointee must be capable of organizing a research program and directing activities of graduate students. Starting salary within range of university salary schedule, supplemented from research funds. File No. 6182-V.

GRADUATE CIVIL AND MECHANICAL ENGINEER required in the construction department of large pulp and paper company located in Maritime Province. Applicant should preferably have pulp and paper mill experience. Salary open for discussion. File No. 6188-V.

TRAFFIC CO-ORDINATOR WANTED, City of London, Ontario. The applicant is requested to state age, educational and technical qualifications, training and experience. A photograph not smaller than 3 in. x 4 in. is to be attached. Salary is subject to negotiations but will be commensurate with training and experience. Applicants will note the following benefits: pension plan; sick leave credits; statutory holidays with pay; two weeks' vacation after one year; three weeks' vacation after ten years. File No. 6190-V.

SALES ENGINEER required by manufacturer of finned tube and products fabricated from it. Graduate age 25 to 35 with one to five years experience. Although travelling is involved it is not of routinized nature. Candidates should either have or be interested in obtaining knowledge of design and application of heat transfer equipment. Selected applicant will undergo training period in London, Ontario, eventually locating in Montreal where he will operate independently. File No. 6192-V.

METALLURGIST. Graduate of Canadian university, might be recent, required to work on metallurgical problems relating to spring manufacture and also on spring design. File No. 6193-V.

OPPORTUNITY to qualify for M.Sc. in hydraulics while employed on industrial research. Opening available for graduate engineer on a project team investigating the forces involved in pulpwood holding grounds on both model and full scale. For first 2 years, appointee will spend half-time during academic term studying for M.Sc. at Queen's University, where project laboratory is located. Requirements: acceptance by Queen's as M.Sc. candidate; aptitude for research, and for working with company personnel in field. Base salary in current industrial range for similar training and experience; half-pay during academic year of 7 months, full pay for remaining 5, including 2 weeks paid vacation (approximates ¾ base salary over 12 months). Apply, enclosing comprehensive job resume in duplicate, to File No. 6198-V.

SALES ENGINEER. Small firm manufacturing industrial instruments and pneumatic controls has opening for two engineers for technical sales work; one in the Toronto area and one in the Montreal area. Ground for opportunity. Send qualifications in detail to File No. 6203-V.

THE MANITOBA POWER COMMISSION requires graduate engineers, preferably with two to three years experience in Canadian utilities. Positions are available in the field of distribution in connection with standards of materials and construction, including metering techniques, primary feeder specification and estimating, and general distribution system improvements. This is an opportunity to gain broad experience in a growing and progressive utility. Head offices are located in a modern building in the City of Winnipeg, which offers excellent facilities in education, transportation and housing. Salary $420.00 to $480.00 in accordance with qualifications. File No. 6210-V.

ENGINEERING SALES. Applicant should have four to five years experience in process plant operations, be 25 to 30 years of age and have senior matriculation or better. Sales experience desirable but not necessary. Reply to File No. 6217-V.

AN ENGINEER around 45 years of age required for illumination sales. A long established company will provide the necessary training to fit a suitable applicant to discuss scientifically designed lighting equipment and its application with architects, consulting engineers, industrial executives, and public utilities. A most constructive opportunity for the right man. File No. 6219-V.

NOVA SCOTIA TECHNICAL COLLEGE invites applications for teaching post in hydraulics and allied fields. Preferred qualifications include M.Sc. degree and some experience in research or design: salary range $5100.00 and up, depending on qualifications. Summers free, for research on professional practice. Address applications to File No. 6220-V.

MECHANICAL OR CHEMICAL ENGINEER required by major coal company for combustion and sales duties in Eastern Ontario and Quebec. Preferably with some experience with steam boilers and instrumentation. Age 27 to 36. Usual welfare benefits such as pension plan insurance and hospitalization. Salary commensurate with qualifications. Replies held in confidence. File No. 6221-V.

DEVELOPMENT ENGINEER. This man can be metallurgical, chemical, or mechanical and should have at least six or seven years experience in design or development work relating to machinery and allied fields and if possible, some experience in development work. In both cases the salaries involved are commensurate with the responsibilities. File No. 6222-V.

METALLURGICAL ENGINEER. The position to be filled is that of chief metallurgist and requires at least seven years experience in the iron foundry field. It involves supervision of production, metallurgy in several plants. File No. 6222-V.

UNIVERSITY GRADUATE in electrical, electronic or mechanical engineering. Knowledge of basic materials including strength of materials, some basic metallurgy and the ability to perform mathematical calculation as applied to the investigation of structural designs under supervision. Experience in the aircraft industry although preferable is not absolutely necessary. Salary according to qualifications. File No. 6228-V.

ASSISTANT PRODUCTION ENGINEER required in one of the western Canadian branches of nation-wide steel fabrication and general engineering company. Qualification desired include actual experience in production engineering, experience and familiarity with machine shop and iron and steel foundry practice. Structural steel and platework fabrication experience would be an asset, also materials handling and methods. Opportunity for early advancement for suitable applicant. Please state age, education and give full particulars of engineering experience and enclose photograph. File No. 6231-V.

RECENT GRADUATE in mechanical or electrical engineering is required to assume complete responsibility for maintenance of multi - million dollar warehouse. This is a challenging position for any young graduate with an eye to the future. All applicants are invited to write giving details, academic record and work background. Location Montreal. File No. 6232-V.

ENGINEERS REQUIRED. Experienced and beginners. Electrical, Civil or Mechanical, with or without experience, for engineering design, relay protection, communications, operation, power plant construction (power house, tunnel, dams, etc.) preliminary surveys. Hydraulics: 5-12 years experience. Must be familiar with hydraulic computations and hydro - electric projects. Load Analysis: some experience in public utility engineering desirable, particularly in statistical analysis and load forecasting. Construction (Electrical); Electrical engineer with 5 years experience or more, preferably in installation of hydro - electric plant equipment. Most of these positions are permanent and include pension plan, sickness benefit, group insurance etc. Good salary and chances of promotion for qualified applicants. Salaries: beginners starting salary: $390.00 per month (1957 graduates). Revisions every six months during 2½ years. Annual revision based on merit and responsibilities. Experienced engineers: good salary based on qualifications and experience. Location Province of Quebec. File No. 6233-V.

GRADUATE ENGINEERS, with successful backgrounds of supervision and responsibility required for Quebec manufacturing plants. Electrical, bilingual with extensive experience in heavy industrial work. Chemical, preferably, bilingual with extensive experience in heavy chemical industry. File No. 6235-V.

GRADUATE ENGINEER required by manufacturer of antifriction bearings for sales engineering position to cover Quebec Province territory. No previous experience required as company provides a broad one year training program in U.S.A. plants. Car supplied and usual fringe benefits available. Position offers excellent opportunity to benefit from expansion program of a growing industry. Preference given to a bilingual man between 23 to 30 years of age. File No. 6240-V.

GRADUATE ELECTRICAL or MECHANICAL ENGINEER, bilingual, required by manufacturer of photo-flash lamps. The plant of this company is located at Drummondville, 60 miles from Montreal. The position offered would involve engineering work in all phases of photo-flash lamp manufacturing; process, quality control, testing, equipment design, layout. File No. 6241-V.

GRADUATE ENGINEER. Medium sized manufacturing company near Montreal specializing in and well known, for its metal products for construction and other industry coast to coast, requires an engineer, preferably mechanical or civil, for the position of assistant to the general manager. The right man will be a self starter with good business administrative experience and record, some sales experience, the ability to get along with people and to grow to fill a more responsible position in management. Relocation allowance provided. Annual vacation with pay. Employee benefits. Salary open depending on experience. Enquiries will be treated confidentially. Apply stating full particulars of experience, age, availability, expected salary, etc. File No. 6246-V.

CIVIL AND ELECTRICAL ENGINEERS required by City of Winnipeg Hydro. Permanent positions. Graduation from a recognized university or college essential. Civil engineers for design, construction and maintenance of dams, reinforced concrete buildings and steel structures. Salary range $375.00 to $590.00 per month. Electrical engineers for design and construction of electric utility generation, transmission and substation equipment. Salary range $375.00 to $524.00. Electrical engineer for utility operation and maintenance work. Salary range $375.00 to $471.00. Salary within range according to experience and qualifications. File number 6247-V.

JARRY HYDRAULICS has immediate vacancies for two stress engineers. One of these is for work on strength of materials used in hydraulic components and landing gear. Some experience in the aircraft industry is very desirable, although consideration will be given to any applicant having a sound mathematical background. The other vacancy is for a senior engineer with experience of shock strut predictions (step-by-step method) and hydraulic damper predictions. This job calls for considerable experience and pays accordingly. Consideration would be given to an assisted passage from overseas. Reply in detail giving background and experience. File No. 6248-V.

SALES ENGINEER required by large engineering company in St. John's Newfoundland, to solicit machining, steel plate (tank) fabrication and general engineering maintenance works from mining, paper, fishing, and other industries. Mature engineer with sound and experienced background in this field will receive a salary fully commensurate with his capabilities in addition to a permanent appointment offering the usual benefits. Please apply stating full particulars of experience, age, availability, expected salary etc. to File No. 6249-V.

OUTSTANDING opportunity for graduate engineers in London, Ontario. A wholly owned subsidiary of a major American manufacturing and mining concern is constructing a $7,500,000 non-ferrous tube mill in London. Require recent graduates to fill mechanical, electrical, industrial and metallurgical engineering positions. Unusual opportunity to join a new energetic organization on the ground floor. File No. 6252-V.

WELL QUALIFIED ENGINEERS required for large development in Middle East. Applicants along with sound technical backgrounds must have good personal characteristics. Technical experts are required in the following fields: administration (or technical) as assistant to chief of bureau; communications; social affairs; civil engineer, communications; electrical; industrial and business; agriculture; animal husbandry; forestry; mechanical; etc. For complete details apply to file No. 6264-V.

SUPERINTENDENT for plastic insulated wire plant in Pointe Claire, Quebec. Must be familiar with all phases of manufacture and equipment. File No. 6265-V.

• CANADIAN DEVELOPMENTS

Engineering Faculties Expand

University of Alberta

The University of Alberta is offering this fall a greatly expanded program of activity in the highway transportation field.

The program involves both a substantial increase in postgraduate work in the highway engineering field and the inauguration of highway research projects in cooperation with the Department of Highways of Alberta, the Alberta Research Council, and the highway industries.

Directed by the civil engineering department, the following courses are being offered: transportation engineering, including planning, traffic and safety; advanced soil mechanics and foundation engineering; the design and control of asphalt and concrete pavements; advanced soil testing; river hydraulics; advanced design of reinforced concrete and steel structures.

The research aspects will include studies of the performance of existing highway construction, the evaluation of the performance of test roads, studies of effects and prevention of frost damage; slide conditions; and chemical soil stabilization.

Dean R. M. Hardy, M.E.I.C, of the faculty of engineering is directing the program; The faculty staff assisting are: Prof. T. Blench, M.E.I.C., Associate Professors S. R. Sinclair, M.E.I.C., and J. Longworth, M.E.I.C., and Assistant Professors Dr. S. M. Breuning, M.E.I.C., and K. O. Anderson.

Assumption University

Officials of Assumption University, Windsor, Ont., have made known their plans for development of four engineering courses and the eventual construction of a $5 million engineering building.

The announcement was made by Rt. Rev. E. C. LeBel, president of the University, and W. H. Arison, chairman of the Board of Directors of Essex College.

In the past, engineering students could take only their first year at Assumption. The new program will allow students entering first year engineering this fall to continue toward their degree at Assumption. The second, third and fourth years will be opened in succeeding years, providing for the school's first engineering graduation class in 1961.

This development culminates more than a year's work by an Engineering Education Committee headed by C. T. Carson, M.E.I.C. Surveys to determine the student potential and industrial needs of Essex, Kent, and Lambton counties, found a discrepancy between the number of engineers required (530) and graduating (280) in the next five years. Questionnaires showed that of the potential engineering students in the three counties, 40 per cent are willing to attend Assumption. Probably one of the biggest attractions to the local students is the tuition fee of about $325.

It is expected, although no direct offers have yet been made, that the industry will share part of the cost of a building and equipment, and a large portion will be borne by the province.

The Engineering Education Committee is a subcommittee of the Essex Academic Committee. Headed by Mr. Carson, vice-president of production of Hiram Walker and Sons, the committee is comprised of local citizens, all graduate engineers. Hon. W. J. Dunlop, Minister of Education of Ontario, has given his whole hearted approval and support, according to Mr. Arison.

The development of the program will be under the direction of Dr. F. A. DeMarco, chairman of the Staff Committee of Essex College. Essex is to retain responsibility for engineering until an engineering faculty is established.

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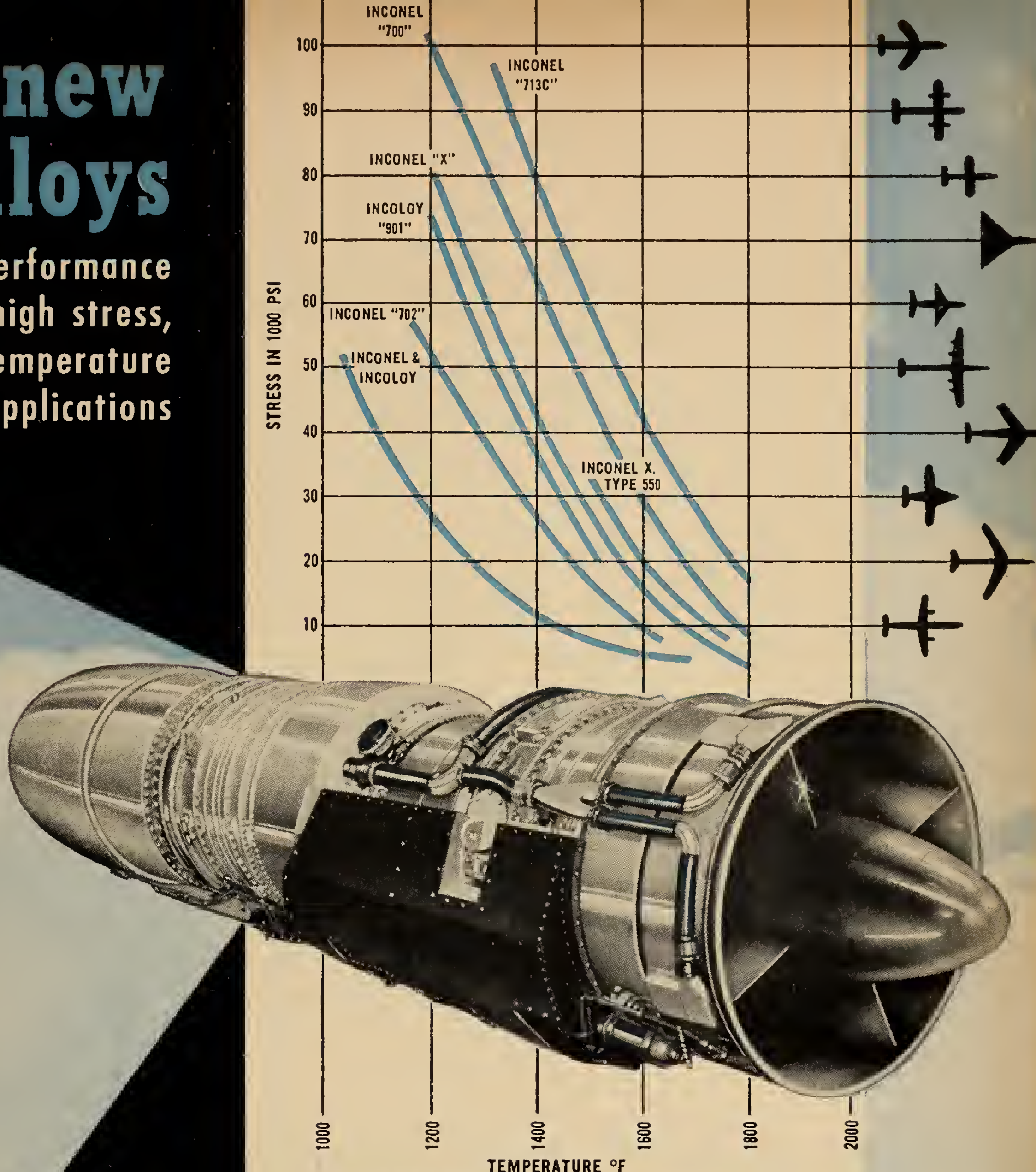

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• OTHER SOCIETIES

(Continued from Page 1344)

Calendar

Lubrication Conference

There will be a joint conference at the Royal York Hotel, Toronto, from October 7 to 9, between the American Society of Lubrication Engineers and the American Society of Mechanical Engineers.

Members of the Engineering Institute are invited to participate under the terms of the cooperative agreement between ASME and E.I.C. If more information is wanted, write to Headquarters, 2050 Mansfield St., Montreal.

Following are some notes on the program: There will be sessions on the subjects of Recent Experiments in Wear; Boundary Lubrication — including highlights of I. Mech. E. London Conference; High Temperature Lubrication; Factors Affecting Contact Fatigue; Fluid Film Lubricated Bearings. The last subject will be dealt with in two sessions, which will also include highlights of I. Mech. E. conference papers on fluid film lubrication.

Power Exhibition

Canada's Power Show will return this year to Toronto, after a four year absence, to be held on October 21-22-23-24, in the new Queen Elizabeth Building in the Canadian Exhibition Grounds.

The power show serves the country's power engineering industry. Running concurrently will be the annual convention of the Institute of Power Engineers, including luncheons, business and technical sessions, all in the same building.

Two features of the Show are an Engineering-Management Seminar, and the nation-wide Cleaner Air Week which is being held in Canada on a nation-wide scale.

The information office for the power show and convention is at 199 Bay St., Toronto, Ont.

Community Planning

The National Community Planning Conference will take place at the Hotel Vancouver, Vancouver, B.C., on September 29-30, October 1-2, 1957.

The sponsoring body, Community Planning Association of Canada, is at 77 Maclaren Street, Ottawa, Ont.

Material Handling

The Canadian Material Handling Show and Conference will be held in Montreal's Show Mart, September 30 to October 4, 1957.

Requests for information and reservations may be addressed to Emile Dupre, Chairman Exposition Planning and Organization Committee, P.O. Box 565, Montreal 3, Quebec.

• OTHER SOCIETIES

Nondestructive Testing

The Society for Nondestructive Testing expects to have delegates from most of the countries in the free world at the Second International Conference on Nondestructive Testing in Chicago, Ill., November 3, to 8, 1957, a follow up of the first international conference in Brussels in 1955.

This conference is being held in cooperation with the Second World Metallurgical Congress sponsored by the American Society for Metals at its annual convention, and in conjunction with the National Metals Exposition.

Canadians will be able to take advantage of plant tours throughout the United States.

Further information can be obtained from the Publicity Chairman of the Canadian group: Wm. E. Havercroft, Dept. of Mines and Technical Surveys, 568 Booth St., Ottawa, Ont.

Civil Engineering

The American Society of Civil Engineers (33 West Thirty-ninth St., New York 18, N.Y.) has available information about the annual meeting, October 14-18, 1957, at which there will be commercial exhibits for the first time in the history of ASCE.

Mechanical Engineering

Meetings of the American Society of Mechanical Engineers (29 West 39th St., New York, N.Y.) are scheduled as follows, during the remainder of 1957: October 7-9, Joint Conference of ASME-ASLE on Lubrication, Royal York Hotel, Toronto, Canada; October 10-12, Joint Conference of ASME Fuels Division and AIME, Chateau Frontenac Hotel, Quebec, Canada; October 21-23, Conference of Power Division of ASME, Hotel Americus, Allentown, Pa.; December 1-6, the annual meeting, Statler and Sheraton McAlpin, New York, N.Y

Engineering Education

The twenty-fifth anniversary meeting of the Engineers' Council for Professional Development (29 West 39th St., New York 18, N.Y.) will be held at the Statler Hotel, New York, N.Y., on October 24-25, 1957.

Standards

How to beat the cost-profit squeeze now harassing business and industry will be the subject of the eighth national conference on standards, to be held in San Francisco, November 13-15, 1957 in conjunction with the annual meeting of the American Standards Association (70 East 45th St., New York 17, N.Y.)

Another meeting on this general subject is the annual meeting of the Standards Engineers Society (P.O. Box 281, Camden 1, N.J.). It will be held at the Hotel Commodore, New York, September 23-25, 1957. Its theme: Standardization — Economy through Application.

Iron Foundry

The Gray Iron Founders' Society, Cleveland, will stage its 29th annual meeting at the Drake Hotel in Chicago on October 9-11, 1957.

Office of the Society is at 930 National City — E 6th Bldg., Cleveland, Ohio.

Stress Analysis

The Society for Experimental Stress Analysis (P.O. Box 168, Cambridge 39, Mass.) schedules the 1957 annual meeting for October 9, 10, 11, at the Hotel El Cortez, San Diego, Calif.

Public Health

Public health authorities representing community, state, national and international agencies, will exchange information on a wide variety of topics at the 85th annual meeting of the American Public Health Association in Cleveland, November 11 to 15, 1957. More than 40 related organizations will hold simultaneous meetings, and a total attendance of 4,500 is expected. Office of the As-

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Contents - October 1957

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WESTINGHOUSE "WORKHORSES"

pull power from St. Lawrence

WESTINGHOUSE SUPPLIES GIANT GENERATING AND TRANSMISSION EQUIPMENT FOR VITAL ST. LAWRENCE POWER PROJECT

Model of giant outdoor generators, now being built by Westinghouse, will help feed 820,000 Kilowatts of new power to Ontario.

Mid-1960 will bring 820,000 Kilowatts of new Hydro power to Canadian homes and industries—vitally needed electricity from Ontario Hydro's mighty St. Lawrence Power Project.

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Structural Steel Design Features and Operating Machinery for Gate Structures in the Locks of the St. Lawrence Seaway

R. W. Willis, M.E.I.C., *Structural Engineer*

J. F. Pilon, JR. E.I.C., *Assistant Mechanical Engineer*

J. E. Coke, JR. E.I.C., *Assistant Electrical Engineer*

The St. Lawrence Seaway Authority

This paper describes the basis for the design of the various lock gates and control valves in the St. Lawrence Seaway, and the main features that have been incorporated in their construction. The mechanical and electrical operating mechanisms are also dealt with.

IN THE accompanying plan of the Iroquois lock, double sector gates are shown at both the upper and lower end of the lock. The small differential head under which this lock will operate after the first year's operation was the determining factor in specifying this type of gate. Under a small head, this type of gate can be opened for both filling and emptying the lock, thereby eliminating the need for filling culverts and taintor valves. Beginning in 1959, this lock will operate under approximately 5.5 foot head. The gates are designed for operation under a lift of 24.5 feet during construction period when water is raised above the Iroquois dam and the river below the dam kept as under present conditions — period 1958 to 1959. Gates similar to these are in operation at the Straits of Canso and the Chicago drainage canal.

Each sector gate consists of two vertical sectorial prisms. The radius of each sector is 48.7 feet, with a 43 degree angle included between its radial axes and having a height of about 43 feet. The sector framing consists of 7 horizontal structural steel sector frames. The skin plate on the outer faces of the curved steel girders forms the curved vertical face of the prism. The outer faces of the radial horizontal frames form the two vertical faces of the prism. The two outer vertical edges of the curved face extend approximately 8 feet beyond each radial vertical face. The two radial faces of each sector are of open framing with vertical and horizontal members, except for the ice guard gratings, the diagonal braces and the plate girders at the bottom of these faces.

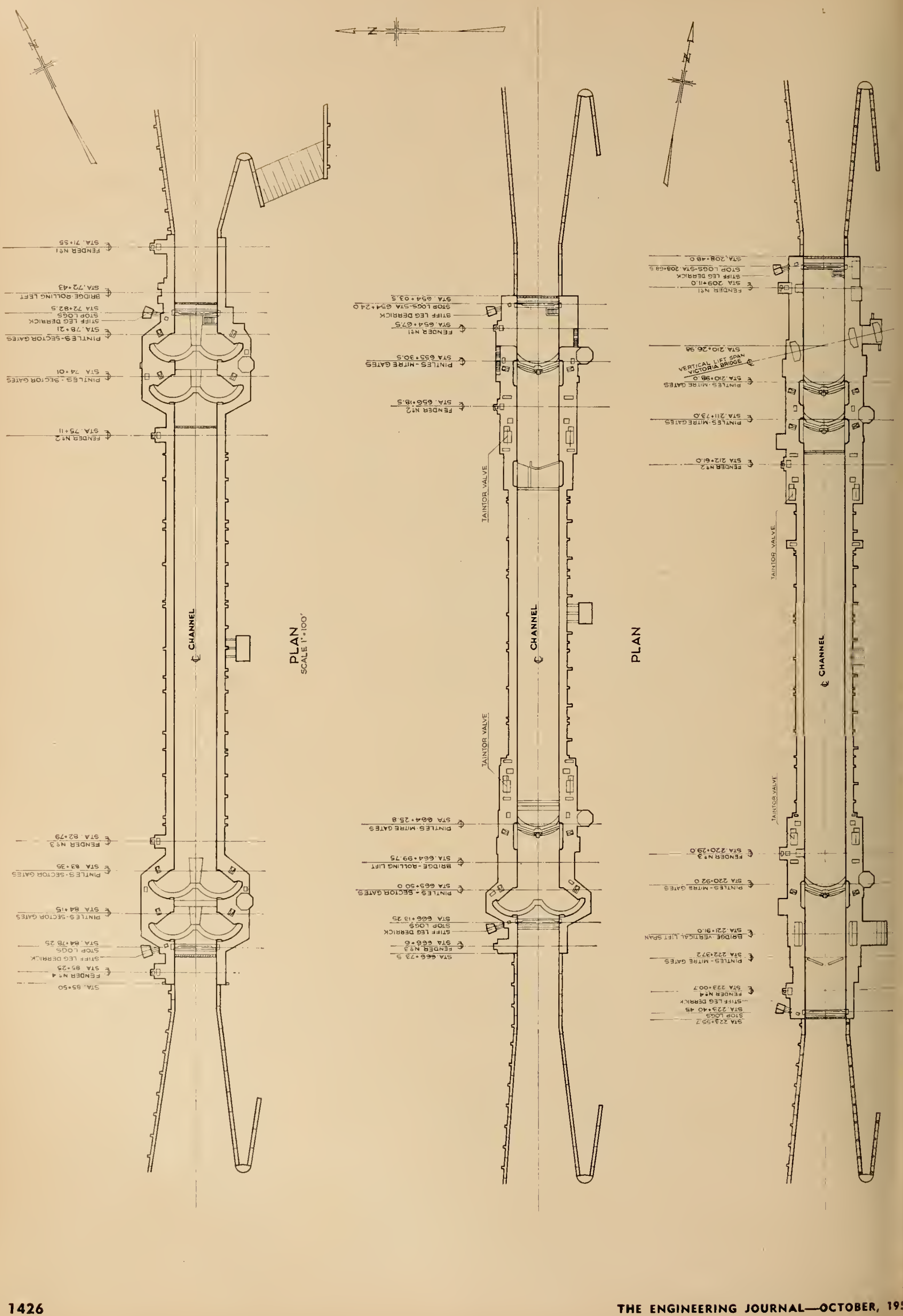
Each sector is supported at three main points—on a pintle beneath the junction of the two radial faces and on the rollers of the trucks which are beneath the outer ends of the radial faces. The rollers travel on a curved steel track and are close to the skin plate. In addition to the 3 main points of support there is a hinge at the top of each sector, directly above the pintle. The upper hinge and the pintle have embedded anchorages which are designed to withstand horizontal loads. The four gates are completely equipped with operating machinery so that, in case of one gate being damaged, the other gate can be immediately brought into use.

A vertical plate girder extends the full height of gate from heel casting to top anchorage. This plate girder transfers all the water load to pintle and top casting. The heel casting is fitted with a bronze bushing which turns on a pintle which is 30 inches in diameter. The pintle is set in a base casting which in turn is connected to an anchorage which extends back into the concrete monolith.

An hydraulic model was made at the National Research Council, at Ottawa, to determine the best type of nosing under flow of water.

The sector gates at Iroquois will normally be the operating gates of the lock, with the second gate at each end acting as a spare. These gates can also be used in an emergency to operate against a differential head of running water.

The sector gates at the upper end of upper Beauharnois lock and the upper end of Cote Ste-Catherine lock act only as guard gates. During normal operation, these gates will be closed immediately behind downbound ships entering the locks. During this normal type of operation, there is no differential head on the gates, other than that which might be caused by occasional surges in the upper approaches to the locks. These guard gates are capable of operating against a differential head of running water, during an emergency. The normal time for opening or closing all sector gates will be approximately 2 minutes. This time will be increased at Iroquois lock when a gate is being opened to fill or empty the lock. During emergency conditions, referred to above, the sector gates can be operated at great-


STA. 71+55 FENDER No 1
STA. 72+43 BRIDGE-ROLLING LIFT
STA 72+82.5 STOP LOGS
STIFF LEG DERRICK
STA. 73+21 PINTLES-SECTOR GATES
STA. 74+01 PINTLES-SECTOR GATES
STA. 75+11 FENDER No 2
CHANNEL
PLAN
SCALE 1"=100'
STA. 82+79 FENDER No 3
STA. 83+35 PINTLES-SECTOR GATES
STA. 84+15 PINTLES-SECTOR GATES
STA. 84+78.25 STOP LOGS
STIFF LEG DERRICK
STA. 85+25 FENDER No 4
STA. 85+50
STA. 654+03.5
STOP LOGS-STA. 654+24.0
STIFF LEG DERRICK
STA. 654+67.5 FENDER No 1
STA. 655+30.5 PINTLES-MITRE GATES
STA. 656+18.5 FENDER No 2
TAINTOR VALVE
CHANNEL
TAINTOR VALVE
STA. 664+25.8 PINTLES-MITRE GATES
STA. 664+99.75 BRIDGE-ROLLING LIFT
STA. 665+50.0 PINTLES-SECTOR GATES
STA. 666+13.25 STOP LOGS
STIFF LEG DERRICK
STA. 666+6 FENDER No 3
STA. 666+73.5
PLAN
STA. 208+48.0
STOP LOGS-STA. 208+68.5
STIFF LEG DERRICK
STA. 209+11.0 FENDER No 1
STA. 210+26.98
VERTICAL LIFT SPAN VICTORIA BRIDGE
STA. 210+98.0 PINTLES-MITRE GATES
STA. 211+73.0 PINTLES-MITRE GATES
STA. 212+61.0 FENDER No 2
TAINTOR VALVE
CHANNEL
TAINTOR VALVE
STA. 220+29.0 FENDER No 3
STA. 220+92.0 PINTLES-MITRE GATES
STA. 221+91.0 BRIDGE-VERTICAL LIFT SPAN
STA. 222+37.2 PINTLES-MITRE GATES
STA. 223+00.7 FENDER No 4
STIFF LEG DERRICK
STA. 223+40.45 STOP LOGS
STA. 223+95.7

ly reduced speeds so as to minimize the hydrodynamic effects of such condition.

Mitre Gates

Each mitre gate consists of two horizontally framed leaves which, when closed, form a three-hinged arch against the hydrostatic load. All mitre gate leaves are approximately 5 feet thick and 46 feet wide. The gate leaf in the closed position is on a bevel of 4 in 12.

The St-Lambert lower gate leaves weigh approximately 175 tons each and are 58 feet high, the Cote Ste-Catherine lower gate leaves 236 tons and a height of 72 feet, the upper and lower Beauharnois lower gate leaves 257 tons and a height of 81 feet. All upper gate leaves weigh 131 tons and are 42 feet high.

One lower and one upper gate at each lock are operating gates. There are 3 spare lower gates; one at St-Lambert lock, one at Cote Ste-Catherine lock and one for the two Beauharnois locks. There are two spare upper gates one for the two Beauharnois locks and one for Cote Ste-Catherine and St-Lambert locks.

All operating gates and spare gates will have identical pintle assemblies and identical upper hinge anchorage assemblies.

All operating gates, the spare lower gate at St-Lambert lock, the spare lower gate at lower Beauharnois lock, and the spare upper gate at lower Beauharnois lock will have embedded sills and quoins. All these gates will be completely fitted with operating machinery.

The spare upper gate at St-Lambert lock and the spare lower gate at Cote Ste-Catherine lock will not be equipped with sills and embedded quoins. These gates will not be equipped with operating machinery. In case of an operating gate being damaged, the gate lifter will remove damaged gate leaves and replace them with spares from the gate storage area.

The horizontal girders in a leaf terminate at each of the vertical leaf edges in the quoin and mitre posts. The quoin post forms the edge next to the lock wall. The mitre post forms the edge next to the lock centre line when the leaf is in a closed position.

The bottom hinges on which the gate leaves turn, are pintles, identical in every case, of 21 in. diameter. The upper hinges are of a simple pin type and are also identical in every case. Each leaf will have a skin plate on upstream side only, the other side will be left open but have adjustable diagonal members. The adjustable diagonal members when pre-stressed will give the gate leaf its required stiffness for operation.

The pintle assembly consists of a heel casting, which will be attached by means of turned bolts to the bottom of a gate leaf at the quoin end, a phosphor bronze bushing which will be inserted in the heel casting, a nickel steel pintle on which the bronze bushing bears and a base casting which will be embedded in concrete and which will support the pintle and gate leaf.

The mitre gates have been designed to withstand the hydrostatic loads and to be operated against a differential head of 0.50 feet. The dead load forces are those which result from the weights of the gates.

The gates will be of welded construction, in vertical sections from 12 to 14 feet. The field connections will be bolted with high tensile bolts.

The normal time for opening or closing a mitre gate will be approximately 2 minutes. Mitre gates installed at the downstream end of a lock may be subjected at times to a severe back surge from ships propellers if the gates are being closed immediately after a downbound vessel leaves the lock. Provision has been made to release such a gate from the operating machine if the force due to the back surge exceeds a strut load of 140,000 lb. plus or minus 10 per cent, when the gate is near the mitreing position. Release is accomplished by the shearing of pins in the gate machinery.

The structural design of mitre gates is similar to the design of the mitre gates on the Welland Ship Canal except that the Welland gates were designed with skin plates on both faces of gates and buoyancy chambers.

The gates on the Welland Ship Canal were operated by a system of sheaves and wire rope to a drum in the control house. The present gates are operated from a sector gear and strut arm.

Gate Machines

A gate receives motion from a strut pin connected at both ends, to the top gate frame member and to a segment arm fastened to a sector gear. The sector gear is driven by a pinion and both gear and pinion are mounted on vertical shafts within steel housings encased in the concrete. The pinion shaft extends down into a room below where it connects to a cone worm reducer. This reducer, with a second reducer (herringbone gear), a travelling nut type limit switch, and the 20 horsepower wound rotor driving motor are all mounted on a welded base frame. The frame is anchored to the machine room floor and it is partly encased in concrete. A thrustor brake and a pilot generator are mounted on a special bracket bolted to one of the motor end bells. The motor, the gear and worm reducer and the pinion shafts are successively joined together by gear flexible couplings.

The strut sector gear and pinion are located in a recess below the lock coping level which is closed by a steel sectional cover. The pinion and sector gear shaft housing are both encased in concrete.

The gate strut encloses three springs which deflect when submitted to both tensile or compressive loads. Two other switches, one for tension the other for compression, are mounted inside the strut and are actuated by the strut stem which moves when the springs deflect. When a load in excess of 75,000 pounds is applied to the strut either one of the switches is tripped and the motor power is disconnected.

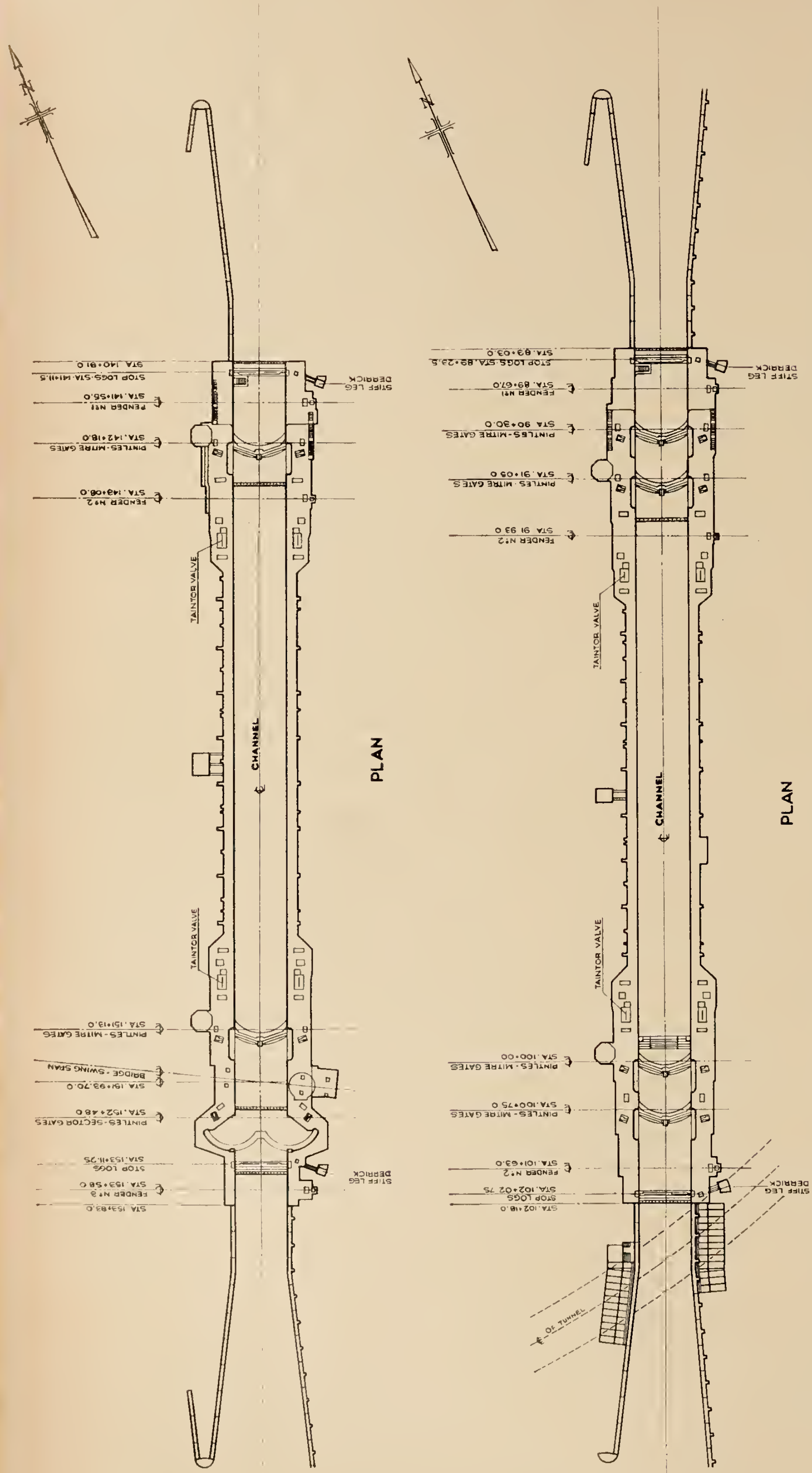
To prevent damage to the lower lock mitre gates when submitted to the high forces caused by waves from a downbound outgoing vessel, a release mechanism is incorporated in the driving pinion and assembly.

Should a wave hit a gate leaf, the force on the gate strut resulting will break the shear bolts in the release mechanism. The gate would then be free to swing partly or fully open. The ratchet teeth of the pinion and coupling will then engage and hold the gate open, thus preventing the surge from closing the gate leaves, causing them to be subjected to heavy impact forces.

Taintor Valves

A taintor valve consists of a horizontally placed sectorial prism of approximately 21 ft. radius in the case of a type "A" valve and 12 foot radius in the case of a type "B" valve. The angle between radial faces is 43 degrees for both valve types. Valve framing consists mainly of 4 radial

From left of page 1426 are plan views of: Iroquois lock; Cote Ste. Catherine lock; and St. Lambert lock.



Above are plan views of the upper (left) and lower Beauharnois locks.

members, which support 2 curved girders and the skin plate which makes up the curved face of the prism. Both faces of the curved girders are covered by skin plates, the skin plate on the outside face being permanently attached, the other being removable for maintenance.

A valve rotates during operation on two steel trunnion pins, one at each side of the valve at the junctions of the radial members. The valve is raised or lowered by means of an operating strut having a cross-head at its lower end which is attached by steel pins to lugs on the valve at the two upper corners of the curved valve face.

Each valve is anchored by the two pins about which it rotates during operation, to a horizontal fabricated beam which is secured at each end in a recess in the wall of the well. The taintor valves have been designed to operate under a 94 ft. water head with the radial members of the valve frames in tension. The dead load forces are those resulting from the weight of the valve in each case. Valve weights are approximately: type "A" 25 tons; type "B" 8 tons.

The type "A" valves are required for opening or closing the lock culverts during filling and emptying of the locks. The minimum times for opening and closing these valves will be approximately 2 minutes and 1 minute respectively. The optimum operating times will be determined finally from operating tests after completion of the work.

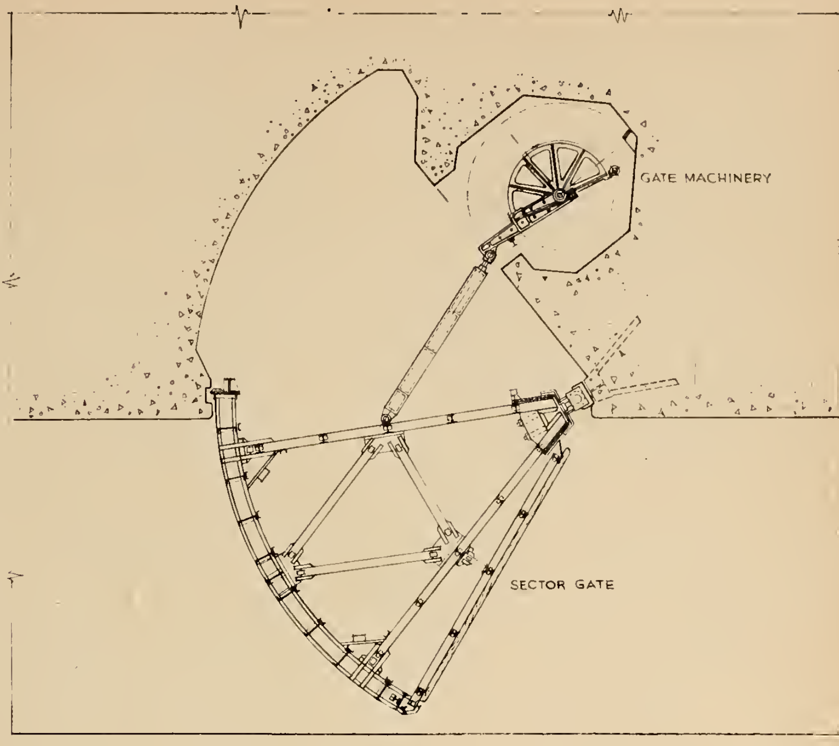
The type "B" valves are required for by-passing water around the upper Beauharnois lock. These valves operate, in the same manner as type "A" valves but are independent of the lock filling and emptying system. The two types of moulded rubber strips forming seals at valve lintels and sidewalls are attached to the valves. Provision is made for seal adjustment in the field. Valves are fabricated by rivetting.

Provision is made for de-watering the taintor valve chambers, should a valve have to be repaired. Recesses are provided at each end of valve chamber in which steel bulkheads are stored. These bulkheads can be lowered to close off the filling culvert and the valve chamber pumped out.

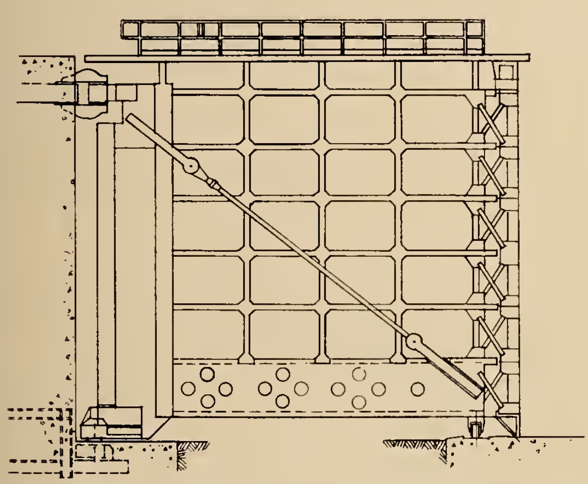
Valve Machines

Each lock valve is operated by a tubular strut, pin-connected to the valve, and to a lever keyed to a shaft. Power for moving the valve is transmitted to the lever shaft through a second lever and strut, a sector gear, and pinion and gear reducers driven by an electric motor.

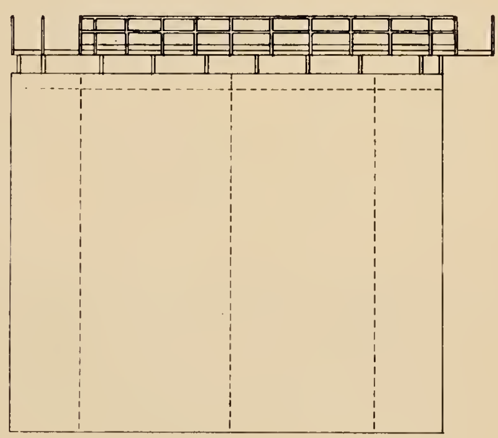
A 20 horsepower wound rotor motor drives the valve machine and it is connected to a first reducer through a floating shaft and flexible couplings. This reducer is in turn coupled to a second one which drives a pinion meshing with a sector gear. A spring strut, pin-connected at both ends, joins the sector gear with a lever keyed to the forementioned valve strut lever shaft. This lever shaft is in three sections. The first carries a lever and is mounted on bearing supports inside the machinery room, along with the motor, reducers, gear, and pinion. The second portion extends through the wall into a wet compartment called the valve well and connects to the third shaft section. A watertight stuffing box separates that portion of the machine which is in the dry from the other in the wet valve well. The third shaft section is identical to the first and is supported on a shelf above the valve well. The spring strut between the sector gear and lever permits overtravel of the machine when seating the valve.



Above is a plan view of one sector of a sector gate, together with the gate operating mechanism. Below are diagrams of the elevation of a similar gate, showing the recess side (left) and the front side (right).



RECESS SIDE ELEVATION



FRONT ELEVATION

The reduction between the motor and valve strut is such that the valve can be raised in one minute. However, the raising speed of the valves varies at each lock and depends on the operating head. The valves are all closed at normal speed; that is, one minute.

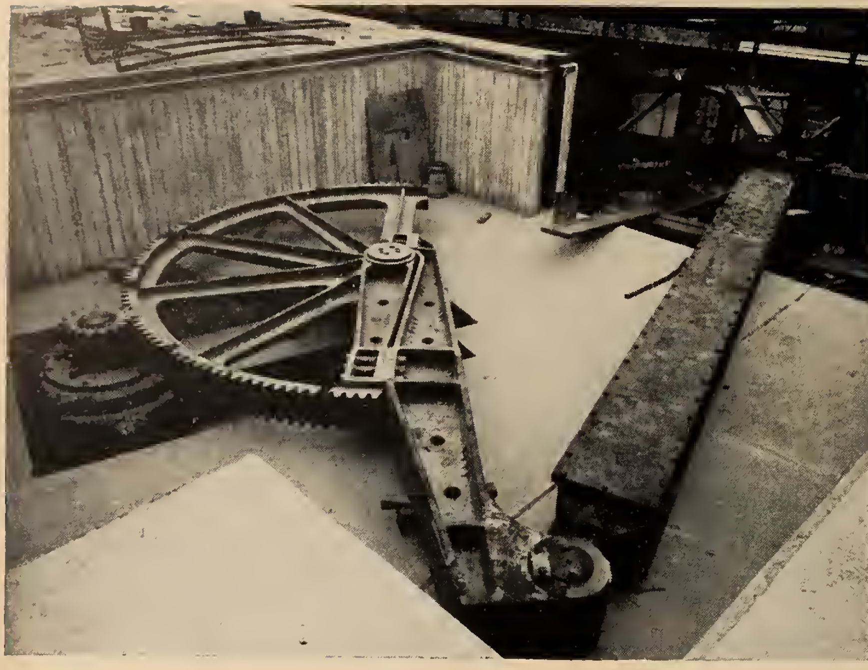
Control Gates and Bulkheads for Regulating Works

Four regulating gates at St-Lambert lock control the flow of water from the intermediate pool between Cote Ste-Catherine and St-Lambert locks. Some of these gates will be operated frequently since these gates control the pool level.

Bulkheads are provided for the unwatering of a maximum of two of the gates at one time for maintenance purposes, or for unwatering the upstream faces of all four gates at one time. This latter case would occur only during the closed navigation season when water could be passed from the intermediate pool through the filling culverts of the locks.

Bulkheads are also provided for the unwatering of the tunnel which passes beneath the south direct approach to Victoria Bridge. This would only occur during the closed navigation season except, perhaps, in an emergency.

The six regulating gates at Cote Ste-Catherine lock control the flow of water from Lake St-Louis into the intermediate pool between Cote Ste-Catherine and St-Lambert locks. This pool is used for shore drainage and sanitation as well as being the intermediate pool for lockage water.



These gates may be operated at quite infrequent intervals after initial adjustment.

The unwatering bulkheads at Cote Ste-Catherine regulating gates are for unwatering the gates on the upstream side only. The water level on the downstream side of the gates will be low enough so that the gates can always be made accessible with only upstream bulkheads.

The two taintor valves, previously referred to, which are to be installed at Upper Beauharnois lock control the flow of water from the Beauharnois power canal into the intermediate pool between the upper and lower Beauharnois locks.

The unwatering bulkheads at upper Beauharnois regulating valves are for unwatering the two valves in the closed navigation season or to unwater either one of the valves, during the navigation season when the other gate would control the flow of water into the intermediate pool.

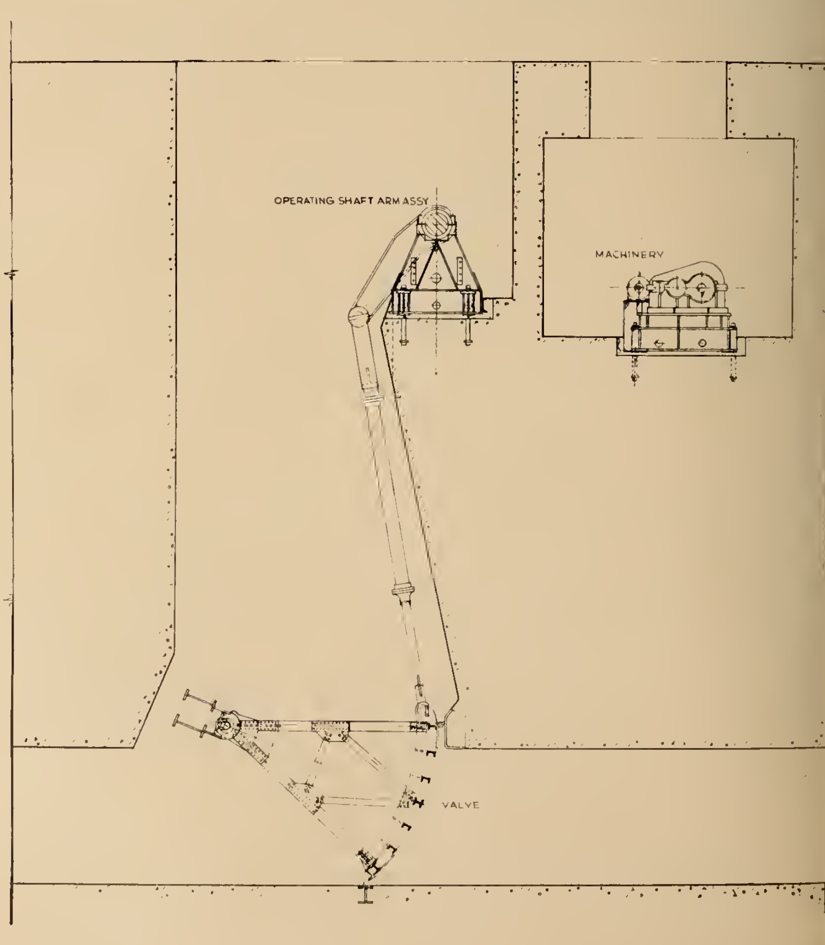
Gates and bulkheads will be fabricated from steel plate and rolled sections with skin plates on one side only by welded construction. The gates and bulkheads form a seal at their outer edges where contact is made with the embedded parts.

Regulating Works Machinery St. Lambert Lock

The gates at St. Lambert lock regulating works may each be raised or lowered by two vertical non-rotating screws. Each screw is pin-connected to the gate and supported by a bronze nut mounted on springs inside a gear casing. There are two screw lifting gear units per gate and each is bolted to an embedded steel frame sitting on top of the concrete piers of the regulating works. A 10 h.p. motor with a speed reducer drives the screw raising gear units connected together with a floating shaft. The springs under the nut permit overtravel of the machine when the gates are being seated. A position indicator and limit switch mechanism is coupled to one of the screw raising gear units for each gate. The position indicator transmits the position of the gate to the control room. The limit switches automatically shut the motor power off when the gate has reached its fully open or fully closed position.

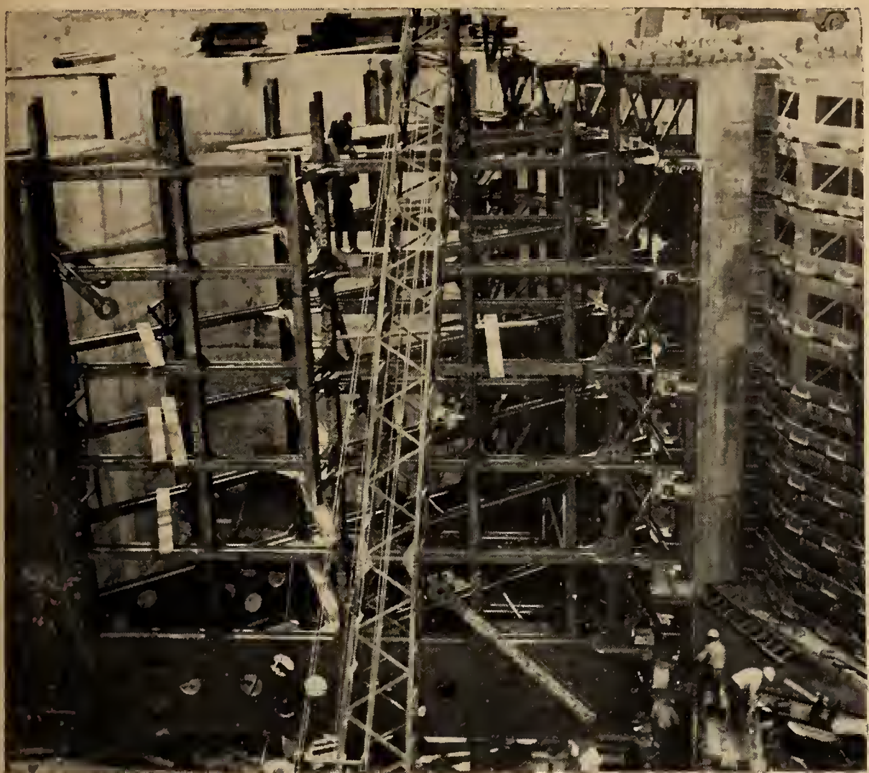
Above, installation of operating mechanism for sector gates at the Iroquois lock.

Below, diagram of a taintor valve in the closed position, with the operating strut assembly.



Cote Ste. Catherine Lock

The machinery operating the gates at Cote Ste. Catherine lock regulating works are basically the same as those operating the St. Lambert lock works. The maximum gate travel is short and consequently the screws are short also. There are two screws per gate and each is completely enclosed within the gear casing and top and bottom housings. Two long gate stems, each sliding inside two guide bearings anchored to the upstream wall, connect the gate to the



Structural steelwork for one of the sector gates at Iroquois lock.

screws lifting it through spring deflectors. These deflectors permit overtravel of the machinery when the gate is being seated. Each gate machine is driven by a 3 h.p. motor. A position indicator and limit switch mechanism coupled with every gate machine performs the same functions as those on St. Lambert regulating gates.

Beauharnois Lock

The taintor valves for regulating the water at Beauharnois being similar to the lock valves, it follows that the actuating machines will also be similar to the lock valve machines. The minimum time for opening is much longer — five minutes — consequently the reduction between driving motor and the valve is proportionally greater. The loads acting on the machines are also considerably smaller, therefore the machine components, levers, shafts, bearings and frames are proportionally smaller. The machine has no travelling nut-type limit switch. It is driven by a 3 h.p. motor. A stress switch on the spring strut as for the lock valve machine serves as the fully closed limit switch. The fully open limit switch, a track type switch, is mounted on one of the lever shaft frames and is actuated by the lever. The two machines, one for each valve, are installed inside a common room within the regulating works monolith. A transmitter coupled to the lever shaft indicates the valve position in the control room.

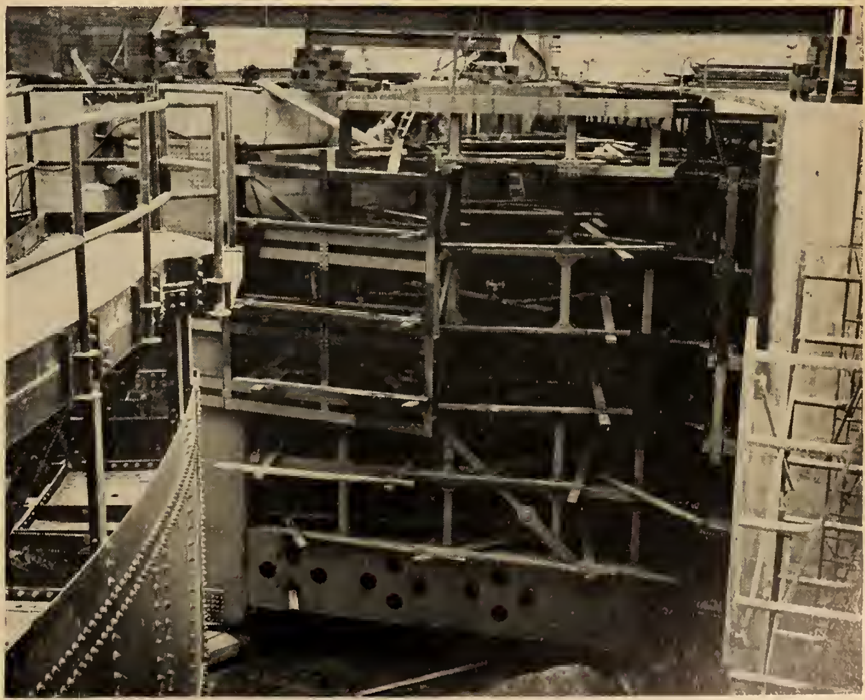
Stop Logs

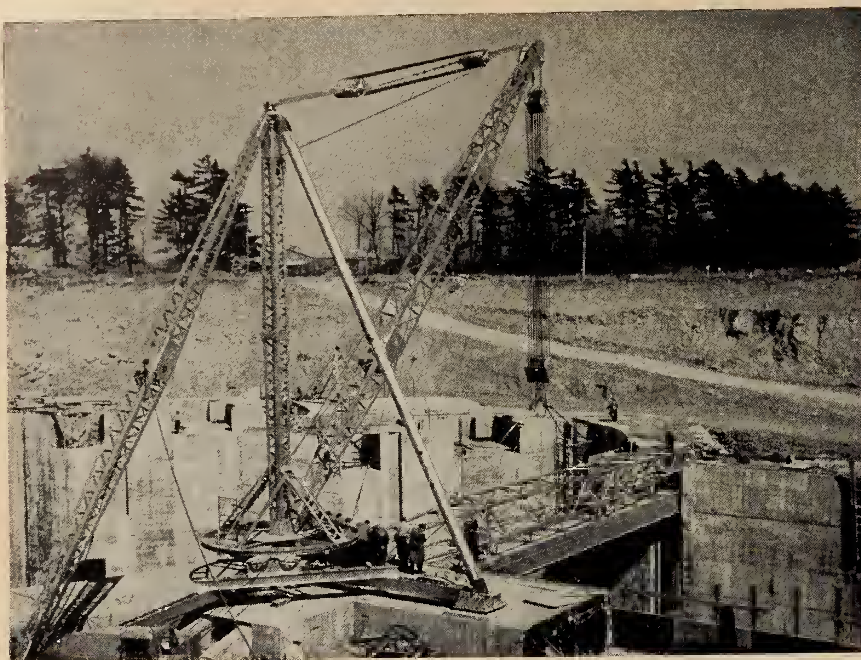
Recesses are provided for the placing of stop logs at both ends of locks. A pick-up boom is designed for the placing of stop logs during an emergency under flowing water. The main purpose of stop logs is for the de-watering of locks during the closed periods of navigation for maintenance work. Each stop log is made up of two horizontal welded plate girders with skin plate between flanges on water side. The water load is transferred to concrete monoliths by means of two reaction rollers at each end of each stop log.

The steel stop logs are designed for installation, one above the other, with the ends in vertical recesses in the sides of each end of the locks, to form watertight barriers which will permit the unwatering of locks for inspection or repair. In order that the barrier will be watertight, a horizontal seal of 1-inch diameter plaited nylon rope will be provided between individual stop logs while a rubber seal will be provided between the end of the stop log and the face of the recess. The depth of stop log girders is approximately 6 ft. 3½ in. out to out of flanges with a span of 83 ft. 6 in. c/c of reaction rollers.

The stop logs will be handled, one at a time, by a pick-up boom equipped with a wire rope lifting sling and one latching mechanism for engaging or disengaging the stop log. The actual placing and removing of stop logs will be done by use of stiff-leg derricks, one at each end

At the left of this picture can be seen part of a completed sector gate, showing the front side and the walk-way above.





Stiff leg derrick (described below) placing stop logs at Iroquois lock.

of each lock. (See illustration above)

Stiff Leg Derricks

Each stiff leg derrick has a lifting capacity of 55 tons at a radius of 55 feet. An 8-part one inch diameter rope fall may be lowered 50 feet down from the 80 foot boom above the centre line of the lock in line with the stop log. The boom may be raised or lowered through an 8-part one inch diameter wire rope system with eight blocks, connected to the top of the boom and the top of the mast. The boom and mast may be rotated from the pick up position of a stop log in the lock recesses through 180 degrees to the rear where the stop logs are stored.

Two stiff legs, one long and one short spread 87 deg. apart are both connected to the mast top through a swivel casting and to the mast base frame with lay legs. The short leg is anchored to the top of the lock wall and the long leg is anchored to a separate concrete monolith setting on fill.

The boom, mast, pulley blocks, stiff legs, lay legs, anchor frames, and the drums and frame are all of welded construction.

The drum unit is anchored to a concrete base also sitting on the fill between the two legs. Two concrete leg spacers between this base and the lock wall take the reaction loads from the lines off the drums. The three drums, one for the load, the next for the boom and the third for swinging are driven by a 75 horsepower motor through spur gear reductions. The drums are individually coupled to their respective drive shafts with magnetic friction clutches. An ammeter in the circuit of each clutch is calibrated in pounds and indicates the corresponding drum rope pull as power is applied to the clutch. Each drum has its own brake with a foot pedal in the operator's cab. All the brakes are connected to a dead man control.

The drum units and operator's cab for the derrick at St. Lambert lock and at the lower end of Cote Ste. Catherine lock are provided with lifting jacks. These jacks will raise the units five feet above the lock wall which will be above the maximum expected spring flood water elevation.

Wire Rope Fenders

The wire rope fenders are installed on each side of the lock gates and their purpose is to prevent ships which have travelled beyond the prescribed limit from damaging the gates. If a ship hits the fender its bow will come in contact with a three part double system of 1¾ inch diameter wire ropes stretched across the lock. These ropes are reeved through sheaves anchored to bollards encased in the lock wall. As the ship continues to advance the ropes unwind from two drums against four friction brakes gear-connected to the drums, thus maintaining a steady rope pull. The kinetic energy from the moving ship is dissipated through the ropes sliding across and along the bow, over friction bollard C just ahead of the drum and through the drum brakes.

Two types of machine elements comprise the complete fender machinery. The exposed machine elements, the sheaves, the boom, the bascule, the boom latch, the bascule frame with driving screws, the bollards and that portion of the rope which stretches across the lock, are outside on top of the lock walls. The housed machinery elements, the rope drums with brakes, the rewinding and brake scouring machine and the bascule drive unit are inside in a machine room within the lock wall.

There are two types of fenders, one called exposed, the other submerged. The exposed fender is the most common one, as described above. The submerged is a special fender with the boom bascule, bascule frame, and driving screws operating under water, and the rope drums, the bascule driving unit, housed in a machine house on top of the lock wall. The submerged fenders are installed on the downstream side of the St. Lambert lower and upper lock gates.

The fender bollards are two vertical steel cylinders 11 feet long encased in the concrete wall opposite one another on each side of the lock.

Two rope sheave blocks are each bolted to one end of an 85 foot boom. This boom also supports the ropes reeved through the sheaves, and is in turn fixed to a counterweighted bascule by two shear bolts at the bottom and two tensile bars with adjusting nuts at the top. The bascule rolls back on frame between two tracks with guides and racks meshing with segment gears on the bascule. Two screws supported on the aforementioned frame and connected to the bascule with a yoke supply the motion to roll the bascule and lift the boom with sheaves and rope out of the way of ships sailing through the lock after the gates are opened.

The screws are driven through a common shaft, spur gear reducers and mitre gears by a 20 horsepower motor whose available torque has been reduced to 75 per cent of its rated full load torque, in order to standardize and use the same motor as is used on the gate and valve machines. In addition to the motor, the driving unit includes a thrustor brake, a pilot generator, and a limit switch,

Typical cubicle arrangement; circuit breaker, lighting, and heating cubicles.

all necessary for the fully automatic operation of the fender.

The two ropes are wound each on a separate drum mounted on two frames bolted together and anchored to the room floor. Each drum has a bull gear meshing with two pinions. One pinion may be clutched to the rewind mechanism, the other pinion couples the drum with two adjustable spring loaded friction brakes.

The brake scouring and rewind unit consists of a 7½ horsepower motor driving a cone worm reducer with a sprocket on the slow speed shaft. A driving chain connects this sprocket with either the brake shaft for scouring or the drum pinion shaft for rewinding the ropes on the drums.

When the boom is lowered the sheave block trips a latch as it drops over the bollard. The latch holds the block on the bollard when the boom is destroyed by a ship crashing it. The latch is released by a thrustor motor before power may be applied to the boom raising motor.

Unwatering Pumps

When the navigation season closes, the locks must sometimes be dewatered for inspection and maintenance of the submerged equipment. Once the stop logs are in place at each end of the lock, the problem then is to pump some 20 million gallons of water in the shortest possible time. This enormous task is performed with vertical deep well pumps installed permanently at the lower end of each lock except at Upper Beauharnois lock. This lock may be unwatered through the reach and the lower Beauharnois lock.

The performance of each pump is such that it can begin pumping out a lock by delivering 19,600 gallons per minute against a 10 foot total head and still deliver 12,900 gallons per minute against a 50 foot total head near the end of unwatering.

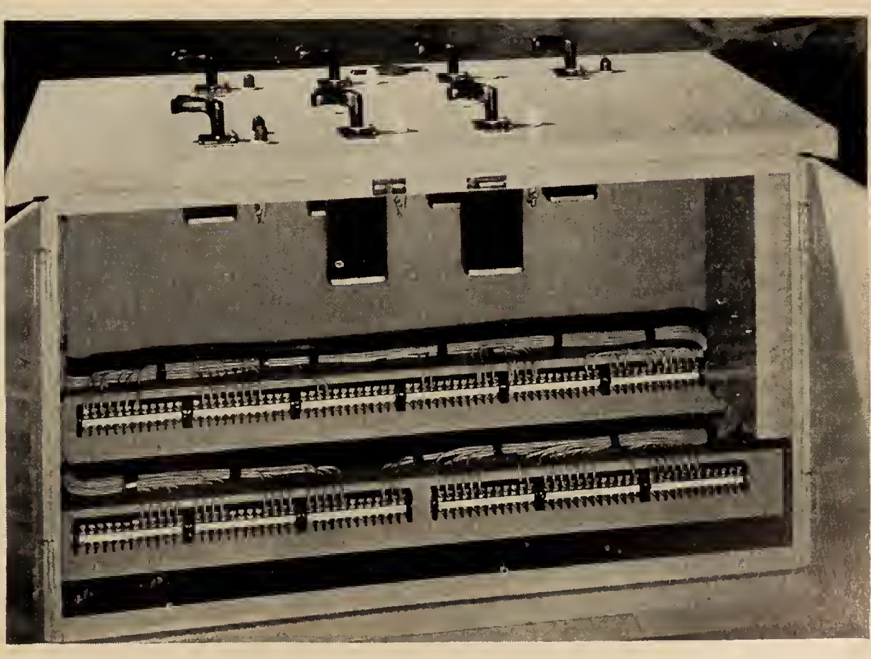
The pumps are suspended inside a deep well within the lock wall extending downward to a pit below the lock floor. This pit is directly connected to the lock chamber immediately inside the stop logs.

Each pump discharge connects to a gate valve, a check valve and then to a pipe inside the lock wall. The discharge end of this pipe is some 19 feet below the low water elevation at the lock entrance and outside the stop logs.

Each pump has a single impeller of the mixed flow design located in the unwatering pit at the bottom of the pump column. It is connected to the 280 horsepower motor in the pump room above the lock wall by a vertical shaft. This shaft extends inside the pump column casing. This shaft is supported at short intervals by water-lubricated rubber bearings. A spherical roller bearing at the top end of the motor supports the vertical thrusts loads from both motor and pumps.

A clear water line from outside the lock below the normal low water elevation supplies the lubricating pumps. These pumps are of the "centrifugal" type with a shaft extending to a 7½ horsepower motor in the pump room above. Each pump discharge extends vertically to the pump room and connects to a supply manifold feeding all the bearings of one large pump. The two manifolds are interconnected so that only one pump can supply the necessary water for lubricating all the bearings of the two large pumps. A pressure switch within the water lubricating

Control desk for the upper end of the Iroquois lock.



system rings alarm when the pressure drops below a set minimum.

Sump Pumps

Concrete tunnels under the lock floor are provided in each lock for the transfer of electrical power and signals from one side of the lock to the other. These tunnels are also used for hydro power cables and telephone cables.

Flooding of the tunnels could prove disastrous in spite of the waterproof materials protecting the electrical wires. To prevent such flooding each tunnel drains into a sump pit at one end. A deep well sump pump keeps the level in the pit at a minimum. These sump pumps are 4-stage vertical column pumps driven by a 7½ horsepower motor and discharging outside the lock. A pump has a maximum delivery of 83 gallons per minute against a total head of 90 feet.

A float switch in the pit starts and stops the pump motor at pre-set levels. A second float switch rings an alarm when the water reaches a dangerous level in the tunnel.

Line Haulers

Since ships must be secured with mooring lines when a lockage is made, line haulers are installed on the lock wall and provide hoisting power for the heavy mooring lines from upbound ships whose deck may be some 30 feet below. These haulers are of the standard yard car hauler type with the capstan enlarged and its speed reduced. A safety switch with a foot-operated tripping car around the base stops the machine in an emergency.

ELECTRICAL FEATURES

Power Supply

All locks being built by the St. Lawrence Seaway Authority are being provided with at least two sources of power. Iroquois lock has one source at 44kv. from the Hydro-Electric Power Commission of Ontario, a second source from two 575-volt 312kva. standby diesel generator sets and a third source at 33kv. from the Niagara Mohawk Power Company in New York State. The upper and lower Beauharnois locks have two sources of supply at 2300kv. from the Quebec Hydro, and Cote Ste. Catherine lock has one supply at 25kv. from St. Lambert Lock and another from a 575-volt 312kva. standby diesel generator set. St. Lambert Lock has two 25kv. supplies from the Quebec Hydro and another from a 575-volt 312kva. standby diesel generator set.

At Iroquois lock, the Hydro-Electric Power Commission of Ontario is providing the substation. On all other locks, outdoor substations are being built by the Authority to step down the incoming line voltage to 575 volts, there being two 600 kva. 3-phase transformers being used in each of the Beauharnois lock substations, and one 600kva. 3-phase transformer in each of the Cote Ste. Catherine and St. Lambert Lock substations.

Distribution

The distribution system on each lock is 3-phase, 575 volts, 60 cycles. Two feeders, each consisting of two 3-conductor 400 MCM rubber insulated lead covered cables connect into the lock distribution system from each substation. Load centres are located in machinery rooms on each side at each end of the locks. The load centre consists of a suitable number of 600 ampere frame 25,000 r.m.s. ampere interrupting capacity air circuit breakers enclosed in conventional cubicles. Each cubicle is connected through a breaker to a ring bus, thus assuring continuous operation should a cable in the ring fail. The load centre supplies power to operate the gates, valves, fenders, line haulers, water regulating works, lighting, heating and the other normal services. The standby diesel generator sets feed directly into the distribution system of the locks on which they are located.

Services

Two cubicles, one for heating and one for lighting, are located adjacent to and in each machinery room.

Heating in the control building, pump houses and all machinery rooms, is done electrically by means of 5kw. and 10kw. 3-phase 550-volt heaters. The control is so arranged that, when the temperature drops below 70 deg. F. inside the room, one phase of the heater comes on. When the temperature drops below 60 deg. F. outside, two phases come on and as it cools to below 35 deg. F. outside, all three phases of the heater are energized. On sector gates, heaters are provided at the seals and on the mitre gates, they are provided in the hollow quoins. These heaters are only energized, when the temperature drops to 35 deg. F., as they are only to prevent freezing. All the necessary control equipment to operate the heaters in any one corner of the lock is located in one cubicle.

The surface lighting on the lock walls consists of 400 watt EH-1 mercury lamps in a suitable luminaire with I.E.S. type III distribution. The lamp standards are on approximately 140-ft. spacing and are directly opposite one another. The calculated initial lighting level is approximately 1.82 foot candles. Constant wattage type ballasts are used and connected to a 230/115 volt multiple system.

All lighting and service outlets for control room, machinery rooms, etc., is at 115 volts.

These loads are supplied from the lighting cubicle in each corner of the lock; each cubicle being essentially composed of a 22 circuit nofuz type panelboard, a 15kva. 575/230/115 volt transformer and suitable contactors to operate the surface and machinery room lights.

Adjustable Speed Drives

The motors and control applied to the gates, valves and fenders are all essentially the same. The drive consists of a standard horizontal drip proof 20 h.p. wound rotor motor fitted with a thrustor brake and pilot generator, the latter being an essential component of a special reactor, magnetic amplifier a.c. speed control, which may be briefly described as follows.

The speed is controlled by varying the torque developed by the motor, and this is done by applying any preset unbalanced voltage to the motor primary. Variable unbalanced voltage is obtained by placing a saturable reactor in one phase of the motor primary, say phase A, which is called the drive reactor. Another reactor called the retard reactor is connected to the motor terminal side, with the secondary of a 1:1 transformer, which is connected to one of the other phases, say phase C. The primary of the 1:1 transformer is connected across phases A and B. The impedances of the reactors are varied by controlling the degree of saturation of the reactor cores. Saturation of the reactors is accomplished by means of the magnetic amplifiers so connected that the output of one is positive, while that of the other is zero. Four windings are used on each magnetic amplifier. The bias winding provides a fixed amount of excitation

(Continued on page 1447)

A 300-ton Gantry Crane for the St. Lawrence Power Project

R. Pemberton-Piggot, *The Hydro Electric Power Commission of Ontario*

R. D. Mutch, M.E.I.C., *Dominion Bridge Company Ltd., Montreal.*

Read at the 71st Annual General and Professional Meeting, The Engineering Institute of Canada, Banff, Alta., June, 1957.

THE ST. LAWRENCE Power Project, which is being built jointly by the Hydro-Electric Power Commission of Ontario and the Power Authority of the State of New York, will have an installed capacity rated at 2,400,000 horsepower. The powerhouse contains 32 units of 75,000 horsepower each and is located about two miles west of Cornwall, Ontario, at the lower end of the International Rapids Section of the St. Lawrence River. The structure straddles the International Boundary which divides it into two similar sections, each with 16 generating units.

The powerhouse is of the semi-outdoor type, with no super-structure over the units. An enclosed erection bay and administration area is located at each end of the structure. Two gantry cranes, one on the Canadian side and one on the American side, will provide the crane service to install and maintain the generators and turbines.

The decision to make the powerhouse of the semi-outdoor type brought with it many problems that were new to Ontario Hydro. When studies of this arrangement for the plant were commenced in 1952, there were no similar stations in service in Canada although the Aluminum Company of Canada's Peribonka plants were then under construction. This caused almost every feature to be the object of considerable study. From the onset, it was apparent that the powerhouse gantry was the key item and that successful operation of the plant was largely dependent upon its performance.

The object of this paper is two-fold—first to describe how the main design criteria, included in Ontario Hydro's specification for the Canadian powerhouse gantry, came to be established and secondly to describe the outstanding features of the final product, which was built by the Dominion Bridge Company of Montreal.

THE SPECIFICATION

It will be appreciated that in our northern climate, the gantry of this type of plant not only has to provide load-lifting facilities, but must also

One of the most important features of the St. Lawrence power development is the provision of crane facilities for the installation and maintenance of equipment. The design of the Canadian installation is described here, and is related to the need for compatibility with the corresponding installation in the United States, section of the powerhouse.

provide shelter for the maintenance staff. This means the crane takes the form of a portable building into which is built a large capacity hoist as well as the main auxiliary equipment for handling small parts. In the case of the St. Lawrence powerhouse, the "building" is about a 57-foot cube, the main hoist has a capacity of 300 tons, and the auxiliary hooks are rated at 15 tons. Some idea of the size and complexity of the crane may be gained from the fact that it has a dead weight of approximately 1,200,000 pounds and contains 31 motors with an aggregate of over 700 horsepower.

The semi-outdoor type of powerhouse imposes a number of restrictions on the main physical dimensions of the crane which has not only to fit the generator pit openings when centred over a unit, but also has to be able to enter the erection bay building. The latter is obviously as small as possible and limits the overall height and width of the crane. The crane must also clear the generator covers, limiting the clear width between the crane trucks. The clear height under the machinery housing is limited by the clearance required for a turbine runner and shaft assembly standing on the erection bay floor, while the maximum lift is dictated by the runner and shaft being passed over a generator rotor in the erection bay or being carried over the unit covers.

These limiting dimensions were correlated between the Power Authority of the State of New York and Ontario Hydro, to establish the dimensions specified. This ensured complete interchangeability of the cranes and would enable the crane from one powerhouse to work in the other during an emergency.

The architectural appearance of the cranes was established to conform with the treatment given to the entire project. This resulted in a much more detailed than usual specification drawing being made which enabled the two entities to purchase two cranes that would be designed and built by two different companies in two different countries and yet be identical in appearance and interchangeable in service. This process defined only the size, capacity and appearance of the crane but did not dictate its performance or the auxiliary equipment.

From the start, Ontario Hydro made a detailed study of the performance requirements as this single unit would be replacing the two overhead travelling cranes normally provided in the Commission's plants. A further factor to be considered was the length of the crane travel as there is a run of 1,350 feet from unit 16 to the centre of the erection bay.

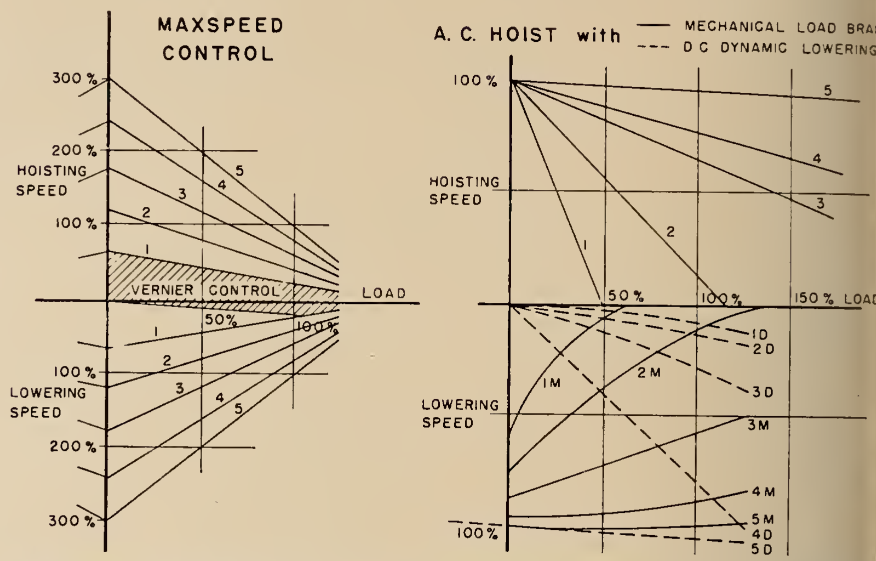
The study was divided into two parts. On one hand there were the functions of the crane when it is stationed over a unit and on the other the problem of providing flexible and adequate service to 16 units with only one crane. The latter is highlighted during the construction period when it is not unreasonable to expect that the two generator manufacturers will both be working on two units each and the turbine erector on a further two; that is, crane service being required, virtually simultaneously, in six units which may be an average 1,000 feet from the erection bay. In later operation of the plant, great demands will be made on the crane when maintenance of say two units is being carried out at opposite ends of the plant.

Considering the crane as a moving building, the problem encountered is that of producing a reasonably weathertight "fit" over a generator pit. To achieve this vertical lift, rolling doors, which seal on a flat sill provided just outside the generator pit curbs, were called for at each end of the crane. Rolling doors were specified, as space limitations within the machinery housing prevented a leaf type door being used. At one time during the study period it became doubtful that any manufacturer would undertake the design of the doors which are the largest of their type ever built. They have a clear opening of 48 feet 4 inches, a clear height of 37 feet 6 inches and are required to withstand a 100-m.p.h. wind load, applied in either direction. Eventually, one company assured us that such a door could be built using a special slat and that it would be capable of operation at the desired speed of 40 feet per minute. On this basis, the rolling doors were included in the specification.

The sides of the crane, below the totally enclosed machinery housing, are sheathed with a material similar to the door slats and complete the enclosure of the area under the crane. A wind seal is provided on the underside of the wheel trucks and sill beam, leaving a gap of only 1 inch between it and the head of the rail.

This form of enclosure, while solving the problem of providing weather protection for maintenance, raises another. Unless other provisions are made the crane has to be moved to pick up or place even the smallest part and during inclement weather this would be an involved process. The gantry doors would have to be raised, the unit covers closed and the crane travelled at least 120 feet to the far side of the adjacent unit.

To eliminate the necessity of moving the crane, except for handling major parts, it was decided to dispense with the conventional auxiliary hook on the crane trolley and to provide two mobile jib cranes that are capable of covering the entire area of the generator pit without moving the crane. The jibs run on the underside of the main transverse bridge girders and may be rotated the full 360 degrees. The booms of the jibs may be passed through a third rolling door in the upstream side sheathing. This permits light loads to be passed through the side of the crane to be placed on a truck located on the upstream roadway portion of the powerhouse deck. The jibs were specified as high performance units having a lift capacity of 15 tons at an 11-foot 6-inch swing radius and a hoist speed of 60 feet per minute.



Example I compares the performance of the Maxspeed control with two common a.c. systems. Hoist speeds are noted as a percentage of the fully loaded hook speed. If the a.c. systems were designed for the same unloaded hook speed as the Maxspeed drive the horsepower of the hoist motor would have to be increased by 300% and the loaded hook speed would no longer be limited to 5 or 6 ft./min.

The inclusion of the two jib cranes helped to solve the problem of flexibility of the gantry, but the fundamental problem remained one of speed or, more specifically, the elimination of dead hook time. The entire question of crane control and crane motion speeds was tackled from this standpoint and the following desirable characteristics were established for the 300-ton hoist and the bridge travel equipment:

(*a*) The unloaded hook speed should be as fast as possible, preferably in excess of 15 feet per minute.

(*b*) The l o a d e d hook speed should be limited to 5 or 6 feet per minute particularly during *lowering* motions.

(*c*) The spotting characteristic of hoist must be excellent and consistent on the lowering cycle.

(*d*) The crane or bridge travel speed should be as fast as practicable for a crane of this size. Again, desirable that this speed be higher for the unloaded crane to reduce dead time (say 200 feet per minute), but limited with the crane loaded to a safe speed with due regard to the ratio of crane weight to load weight (say 100 feet per minute).

(*e*) The "spotting" capabilities of the bridge controls must be excellent as it must be possible to locate the loaded crane (a total mass of approximately 1,800,000 pounds) within 1/16 inch.

(*f*) The characteristic of the trolley motion was not particularly important as the average traverse required does not exceed 12 feet. However, the "spotting" quality should be good.

It will be seen from the above that what was required was a "constant horsepower" system with considerable emphasis being placed on the lowering capabilities. It is interesting to note that in powerhouse maintenance work, the lowering characteristics of the hoist are far more critical than the hoisting ones. This is because the lowering of a 275-ton rotor into position, or a 21-foot diameter turbine runner into the discharge ring with a side clearance of ⅛ inch, is a very delicate operation.

An analysis of the crane control systems in general use was not encouraging as the great majority of applications place the emphasis on the hoisting characteristics and in the main it is along this line that development seems to have taken place. The final choice appeared to lie between normal wound rotor hoisting with rectified d.c. dynamic lowering and a modified Ward-Leonard system which would incorporate both regenerative and dynamic braking and a vernier control for spotting. The former had the advantage of being an a.c. system with its attendant simplicity, while the latter could be arranged to fulfill every desired requirement.

Electrical Features

The electrical specification for the crane was based on a modified Ward-Leonard drive as it was considered that the accuracy and flexibility of the resulting performance would prove a worthwhile investment.

The electrical equipment has been supplied by Canadian General Electric and the control arrangement was derived from their "Maxspeed" system. The basic Maxspeed system was modified to include every one of the desirable characteristics mentioned above. The crane motions are inherently limited by the load and a vernier control has been included which permits the operator to float the load into position.

The complete arrangement may be considered as being unique in its field and the principle of the system is described below:

The Maxspeed system is fundamentally a variable voltage d.c. drive. The equipment is so arranged that a master switch position selects an output horsepower and the speed of the motion is thus dependent upon the load. The system is self-compensating and functions in both the hoisting and the lowering directions.

The crane is provided with one a.c./d.c. motor-generator set which is used to power the main hoist, bridge travel and trolley traverse motions. The use of a single M-G set has been made possible by restricting the operator to the use of only one motion at a time.

This may sound at variance with the concept of increasing the flexibility of the crane but due to the physsical configuration of the powerhouse structure and equipment there would be very few occasions when it would be possible to use more than one motion at a time with any great advantage.

The Maxspeed control is available on all motions and this has been achieved with only one set of control equipment. The only exception to this is the vernier or "load-float" control which is not included in the trolley motor circuit. Simplification of the circuits is assisted by the fact that horsepower rating of the hoist motor is approximately equal to the sum of the bridge motor horse-powers.

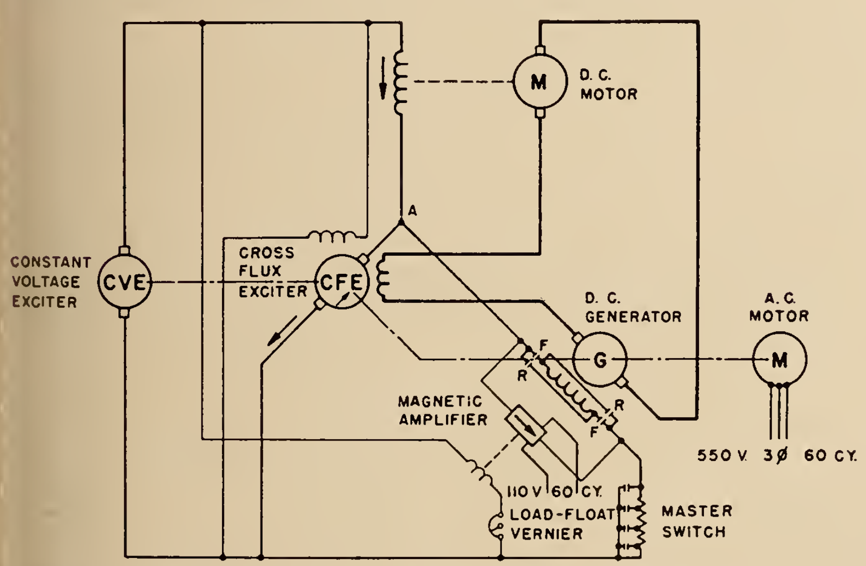
The heart of the system is a d.c. machine known as a cross flux exciter (C.F.E.). This is mounted as part of the a.c./d.c. M.G. set and is provided in addition to the normal generator exciter.

The C.F.E. is arranged so that its output is combined with the basic field current of the controlled motor and may increase or decrease its value. The stator of the C.F.E. carries two windings which are arranged to oppose each other. The one winding is energized by the constant voltage exciter and the other carries the motor armature current.

To clarify its effect, let it be assumed that the output voltage of the main d.c. generator and the basic excitation of the motor have been set by a certain master-switch position, that the hoist motor is lifting a certain load, and conditions are electrically stable. If the load is now increased, the motor speed will be reduced with a corresponding increase in armature current. The increase in armature current will further shade the constant voltage stator winding of C.F.E. and consequently cause a reduction in its output. As the output of the C.F.E. is bucking the motor-field current any reduction will cause an increase in the latter. The increased field current increases the motor torque and thus maintains the motor output horsepower in spite of a lower speed.

The main generator field winding is also connected in series with the motor field and in parallel with the C.F.E. armature. Thus, change in the exiter output has an effect upon the generator field as well as the motor field. Connection of the equipment in this manner makes the effect of the C.F.E. self-compensating and unchanged by the direction of the rotation of the motor or the direction of the load.

In this way, for any particular master-switch position, the cross flux ex-



Example II shows the basic form of the Maxspeed circuit. The output of the cross flux exciter changes the potential of the connection A and thus varies the motor and generator field currents. The "forward" and "reverse" contacts, F and R, are shown on the generator field connections and the direction of this field (and so the direction of rotation of the motor) has no effect on the function of the C.F.E.

citer maintains a virtually constant output horsepower in all four quadrants of the speed/torque diagram. The master-switch positions in this case select a horsepower, and the actual speed of the motion is dependent upon the load. The entire system has an inherent stability and a three to one speed ratio can be obtained without the customary undesirable characteristics of excessive field weakening. This is assisted by the fact that the full load rated-hook speed of the hoist motion has been geared in at 82 per cent of the base speed of the motor.

An important feature of the system is the inclusion of a vernier control which is operative on the first point of motion. It is arranged so that the power of the first point (20 per cent horsepower), may be smoothly reduced to zero. This enables the operator to "float" a hoisted load by reducing the motor speed to a point where it stalls. Creep lowering may then be carried out by further reducing the motor torque until the load overhauls the drive. This brings out the unusual point that high-precision lowering is carried out with the master switch set at the first point of hoist.

For precision movement of the crane, the vernier is used in the opposite manner. The first point of the desired motion is selected on the master switch simultaneously with the value of the vernier that reduces the torque to zero. The shading effect of the vernier control is then reduced until here is sufficient torque to start the motion.

All the motors are of the heavy-duty mill type with forced ventilation by separate a.c. blowers and the only limit to the slowness of a motion, or rather the duration of a stalled condition, is the current-carrying ability of one pair of commutator bars. The design value for this is at least five minutes, giving more than enough time for the operator to set the brake by returning the master switch to the "Off" position. If the vernier control is not moved and the master returned to the first point, the hoist motor will once again hold the load without any hook movement taking place.

Regenerative braking is used in the system for deceleration and electrically-operated brakes are used for holding. The inertia of the M-G set is such that even in the event of a power supply failure, a very normal type of stopping action takes place with both regenerative and dynamic braking being used. The system has been made as safe as humanly possible and it is considered that the inherent speed limitation with load is particularly valuable in this respect.

All other drives on the crane are a.c. powered and are standard in nature. The jib crane hoists are provided with wound rotor motors and mechanical load brakes and the trolley and slewing motion are powered by squirrel cage motors. The main a.c. controls are grouped in a motor control centre mounted on the downstream side of the crane, beside the main cab. The centre contains such items as the contactors for the main M-G set, motor blowers, thrustor brakes, as well as such disconnects as those for the jib cranes, doors and the service gantry. Also included in the control centre is the 15-kva. lighting transformer, its associated distribution panel and the main contactors for the power supply.

The arrangement of the main contactors and the power-supply feed is worthy of note. The crane draws its power from a 575-volt, 3-phase conductor system that runs the entire length of the plant from one erection bay to the other. The conductor system has three gaps in it; one between each erection bay and the switchgear building and one at the International Boundary. The gaps require that the crane be fitted with two sets of current collectors, spaced so that there is always a set in contact with the bus. Both sets of shoes are normally connected to the motor control centre so that the crane may pass from the erection bay to the powerhouse proper without any interruption in supply.

A different situation however exists at the International Boundary. The portions of the conductor system in each powerhouse are electrically separate and are supplied independently. Special steps had to be taken to prevent the crane acting as a tie between the station service supplies

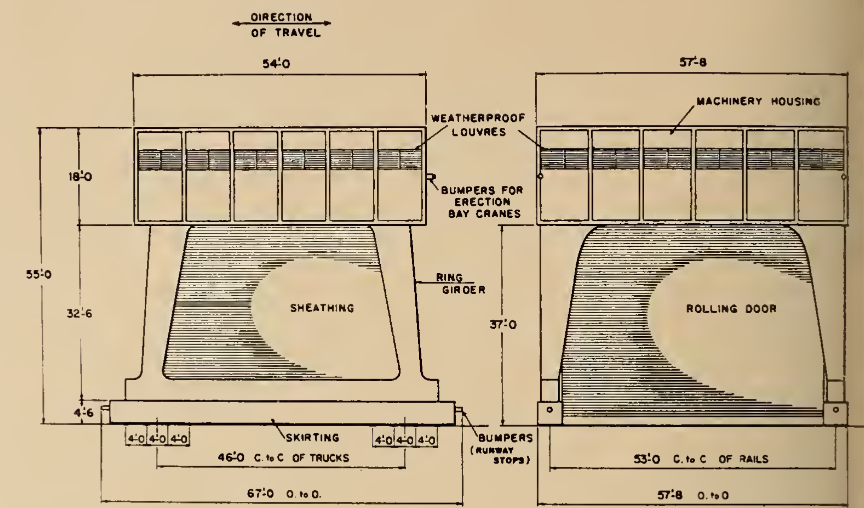


Fig. 1

of the two powerhouses, which may or may not be in phase. A suitable arrangement of limit switches and controls was finally agreed upon and their function may be briefly described as follows:

As the crane approaches the boundary, a limit switch is actuated by a striker bar mounted above the conductor system housing. This opens the contactor for the leading collector shoe assembly, isolating it from the control centre. This ensures that the collector shoes will be de-energized as they leave one section of the conductor system and enter the gap. When the leading shoes make contact with the conductor system on the far side of the gap they are still disconnected. The crane continues to draw its power from the trailing shoes until a second or trailing limit switch reaches the striker bar. The second main contactor is then opened, disconnecting the trailing shoes. At this position the crane is isolated from its supply and so remains until it has travelled, by its own inertia, for one further foot. The leading limit switch then drops off the striker bar, reclosing the leading shoe contactor. A timing relay is incorporated into the control circuit of the contactors to give a minimum time interval between the opening of one contactor and the closing of the other. This ensures that the trailing shoe contactor has been fully opened, even if the crane passes through the gap at full speed.

This type of detail design is typical of many items which were co-ordinated between Ontario Hydro and the Company and were also influenced by the international aspect of the project. The remainder of this paper has been prepared by Mr. R. D. Mutch of the Dominion Bridge Company and describes some of the problems which faced his organization in meeting the requirements of this crane.

DESIGN OF 300 TON GANTRY CRANE

The open deck type of powerhouse originated with the Tennessee Valley Authority and has been adopted for several installations in this country. However, climatic conditions have necessitated various changes and additions to the original designs when used in Canada, including the design of the power-house gantry cranes. This is particularly noticeable in the crane under discussion, which is obviously a normal open leg gantry crane with the spaces around and between the legs filled in by doors and sheathing. (Fig. 1)

Previous Canadian designs of enclosed power-house gantry cranes, such as the 250 ton machines at the two Peribonka sites of the Aluminum Company of Canada, the 175 ton crane at Sir Adam Beck Pumping Station No. 2 of H.E.P.C.O., at Niagara Falls, and the 175 ton crane now under construction for the Shawinigan Engineering Company at Beaumont Development, Quebec, were designed as movable buildings and present an unbroken exterior surface without any indication of the main crane structure within. As a result, the gantry frame could be of any desired form and, actually, in each of these cases, was a simple braced structure, composed mainly of reinforced rolled shapes. This type of structure presents no design problems as far as the load carrying members are concerned. Once these are determined, the main consideration is to ensure adequate bracing in the horizontal plane to maintain squareness of the structure and alignment of the trucks.

On the other hand, the gantry frame for the St. Lawrence powerhouse crane, being largely exposed to view, was designed to conform as noted in the first part of this paper, to the architectural treatment of the whole project. This requirement naturally decided the actual shape and overall dimensions of the main members of the structure in the plane parallel to the runway rails. In the other plane, the dimensions were fixed within fairly narrow limits by the clearances required to pass other equipment and structures on either side of each rail.

While this was, to some extent, of value to the manufacturer in establishing the proportions of the members, it might have resulted in some loss of flexibility of design and, possibly, uneconomic material distribution. In the event, the very exhaustive stress analysis applied to the solution showed that the proportions had been judiciously selected and the material required was in no case extremely heavy, considering the size of the structure and the loadings imposed upon it.

The height of the main hook above the runway rails, together with the available headroom, influenced the design of the trolley very considerably and another potent factor in this respect was the presence of the two 15 ton auxiliary jib cranes whose tracks are supported at the bottom flange of the main trolley girders. This latter consideration was to have a strong influence on the design of the trolley girders themselves and presented a difficult problem when the clearances came to be laid out around the operating machinery of the door in the upstream face of the legs.

The end doors were determined by the clearances required for the unit covers and were also designed

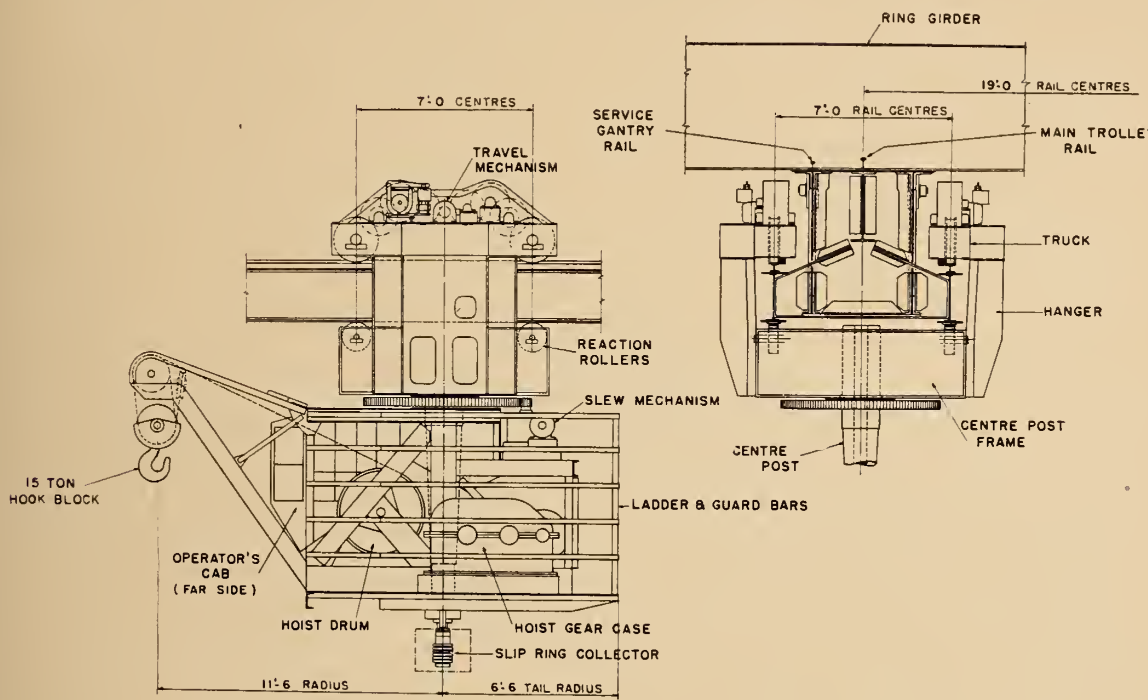


Fig. 2

so that when the crane travels with a rotor suspended from the hook, the doors can be lowered far enough to provide weather protection for the load. This consideration had to be taken into account when positioning the main control cabin and, particularly, the gantry travel auxiliary control point.

Auxiliary Jib Cranes (Fig. 2)

It soon became apparent that the feature which would exert the greatest influence on the design of the Canadian gantry crane would be the auxiliary jib cranes. These were, therefore, the first items to be designed. The rated load of each had already been specified as 15 tons and, as the gauge of the 300 ton trolley rails was estimated to be 19 feet, the radius of the jib cranes was fixed at 11 ft. 6 in. This gives full coverage over the area of the generator pit and also gives the outreach required beyond the upstream legs when projecting through the doorway on that face. A condition was visualized in which the two jib cranes could be worked together when projecting through this doorway and this condition governed the width of the door.

The question then arose as to whether the jib cranes should be fully balanced, partly balanced or not balanced at all. It was obvious at once that the tail radius of each crane would be limited by the need to clear the main hoist ropes of the trolley when the 300 ton block was at its lowest point. If the trolley drum shaft were mounted, as is usually done, at 90° to the trolley girders, the ropes leading from the drum would spread almost as far as the inner edge of the girders and the tail radius of the jib cranes would be much too short to accommodate the hoist motor, drum and gear-case. It was realized, at this point, that, with a total main trolley travel of 25 ft. 0 in., the main hoisting drum could be fitted in with its axis parallel to the trolley girders and thus confine the working space occupied by the main rope system to a narrow rectangle about 40 ft 0 in. long and 4 ft. 0 in. wide. This arrangement allowed the tail radius of the jib cranes to be fixed at 6 ft. 6 in., which made sufficient space available to the rear of the centre post to mount the hoist motor and electric brake. Even with this tail radius, it appeared that the amount of counterweight necessary to restrict the movement of the centre of gravity under full load and no-load conditions to within the track gauge would be excessive and would add considerably to the dead weight and wheel load of the gantry crane. It was decided, therefore, that no counterweight would be used on the jib cranes. Thus the centre-post round which the jib crane revolves was designed to take the bending and direct tension due to the load acting at the 11 ft. 6 in. radius, less whatever reduction could be made by placing heavy items of machinery behind the centre of rotation. On laying out the design, it was found that the 75 h.p. hoist motor with its electric brake and the 5 h.p. slewing motor with its worm gear, brake and machinery could be so mounted.

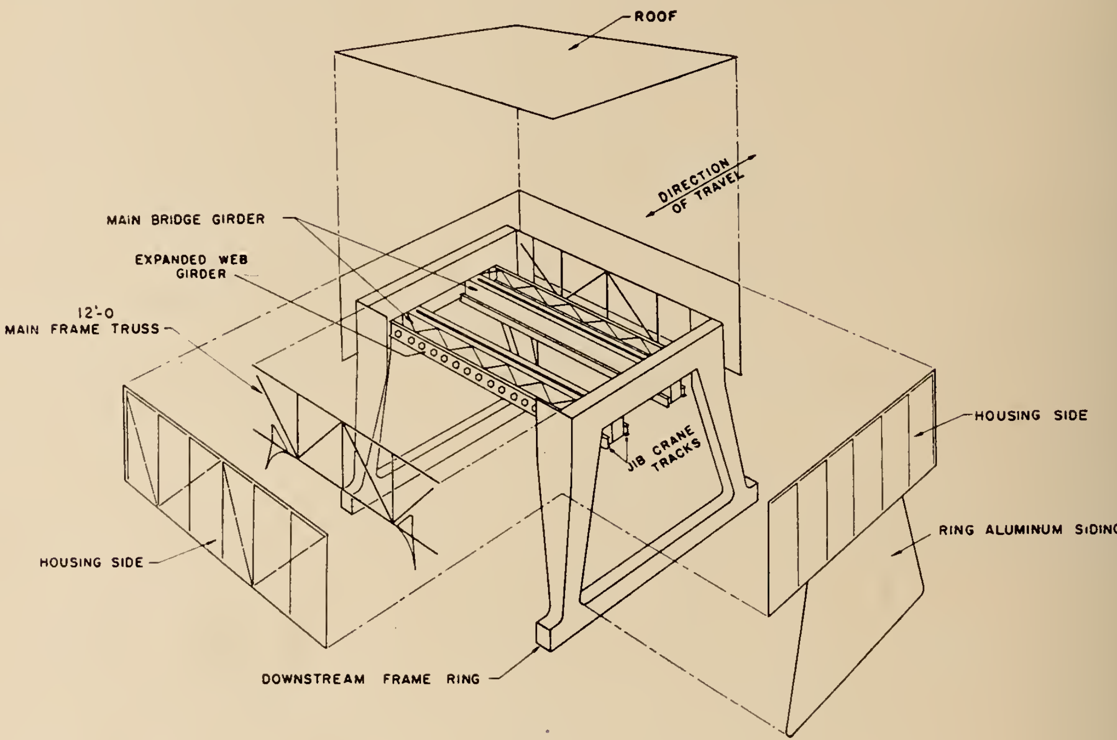


Fig. 3

To ensure maximum visibility fo the operator, the control cab is posi tioned as far forward as possible an to one side of the jib, and is provide with windows all round the operat ing position and in the entrance doo which is at the rear. A walkway a the cab floor level permits mainten ance and inspection of the machiner and is provided with a gate throug which access is obtained to the jil cranes from the stairway landing a the roof level of the control hous on the downstream leg of the gantr Normally, the cranes are parked a the downstream end of their track and with the jibs pointed upstrean Thus the gates on cranes and lan ing coincide and give easy and sa passage to and from the cranes. How ever, provision was required for th operators to leave or enter the ji cranes under emergency condition This was catered for by a syste ot ladder-like bars, placed around the lower walkway of the jib cranes, which serve as guard rails and by which the operator could reach the trucks and thence climb on to the main walkway at the top of the main girders.

The 15 ton load is lifted on four parts of ¾ in. diameter wire rope, two parts of which wind on the hoist drum. The hoisting speed is 60 f.p.m., and the 75 h.p. 1200 r.p.m. wound rotor motor is controlled by a reversing drum switch with secondary resistors.

The hoist drum rotates on bronze bushes on a fixed shaft. It is driven through spur gears, the high speed reductions being enclosed in a cast-iron gear case fitted with bronze bushes and a helix-type mechanical load brake is incorporated in the gear train. This brake serves to control the speed of lowering in conjunction with the resistor notches of the reversing drum, but is inoperative when hoisting. An automatic electric brake is mounted on the motor shaft, and limit switch protection against over-hoisting is provided.

The slewing gear is driven by a 5 h.p. 1200 r.p.m. squirrel-cage reversing motor controlled by a single speed master switch and magnetic reversing starter, giving a slewing speed of 2 r.p.m. The drive from the motor is transmitted through a fluid coupling to a vertical-type worm-gear unit, the output shaft of which carries the main slewing pinion which meshes with the slewing gear ring bolted to the centre post frame. A foot operated brake is provided to control the slewing motion and this is mounted on the extended input shaft of the worm unit. Full slewing of 360° in either direction is possible.

The centre post is a hollow steel casting and suspended from a welded steel frame into which it is keyed and bolted. The unbalanced moments of the revolving part are transmitted to the centre post by steel rollers at the upper level of the jib frame and by a bronze bush at the lower level. The vertical loads are carried by a ball thrust bearing which is retained by a heavy nut screwed to the lower end of the centre post and securely locked. The slip ring collector which carries current from the runway conductors to the control equipment and from the controls to the jib crane travel motors on the upper truck frame, is mounted below the centre post nut.

As the unbalanced moments are much in excess of the stabilizing moment of the jib crane trucks, etc., reaction rollers are mounted in the centre post frame and these run on machined ways welded to the underside of the jib crane track beams. These rollers take the upward reactions due to the unbalanced moments, while the downward reactions and weight of the crane are carried on four cast steel double flanged wheels running on rails fixed to the top of the jib crane track beams. All four wheels are bronze bushed and rotate on fixed axles. All are driven so that irrespective of the jib position, at least two wheels will have driving traction. Two 3-h.p. 1200 r.p.m. reversing squirrel-cage motors each drive two wheels on one rail through fluid drive and spur gears, giving a speed of travel of 40 f.p.m. Braking is by automatic electric brakes.

The wheel trucks and the hanger brackets connecting them to the centre-post frame are of welded construction.

The jib cranes operate on 550 volts 3-phase 60-cycle alternating current and this power is picked up from enclosed conductor systems mounted alongside the main girders. From the collectors the wires pass down through the hollow centre-post to the slip ring assembly and return from there to the jib crane travel motors by the same route.

The control cabs have sliding windows at the front and these, together with the rear-view windows in the door, are glazed with Thermopane glass to minimize the risk of fogging or freezing when working in cold weather. The cabs contain the hoisting drum switch, the master switches for slewing and travelling, the slewing brake pedal, the crane protective panel, main switch, auxiliary switches (including lighting and heating), and an adjustable seat for the operator. Each jib crane weighs approximately 28 tons, excluding load.

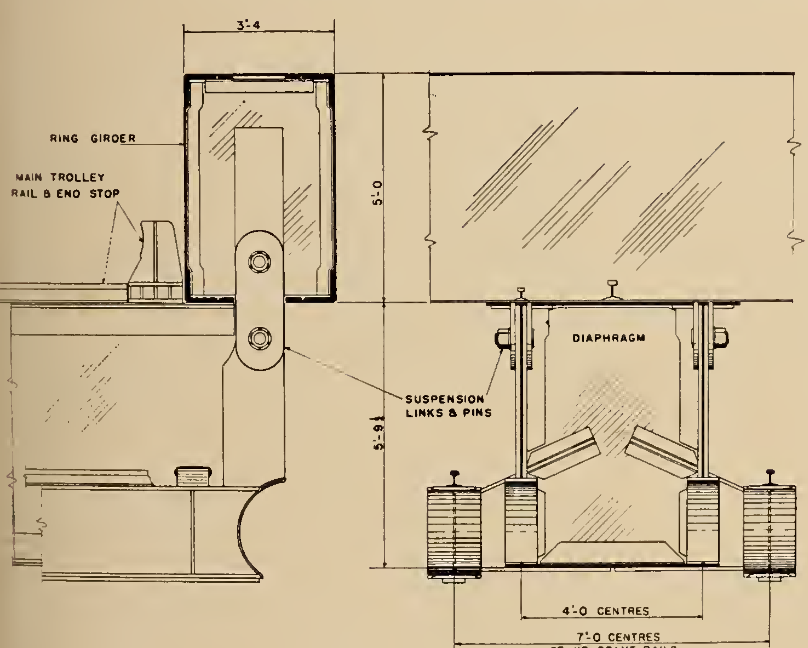


Fig. 4

Main Gantry Frame (fig. 3)

The main gantry frame consists of a pair of vertical ring girders located centrally above each runway rail. The lower horizontal surfaces of these rings carry the pivots for the trucks while the upper horizontal elements support the main trolley girders and the machinery house. The vertical elements of the ring girders form the leg members of the portal structure and carry the guides for the rolling doors.

The tracks for the jib cranes consist of rolled steel beams carrying rails on their upper surface and the machined ways for the reaction rollers underneath. These tracks are arranged in pairs, one pair for each jib crane with the rails at 7 ft. 0 in. centres and are carried from the main trolley girders by brackets which are corrected to diaphragms placed between the webs of the box section main girders. The spacing of these diaphragms is such that the stress in the track girders is kept within the specified limits when the jib cranes lift their rated load with the jib in such a position to produce the maximum wheel load on any one or two wheels. Due allowance was made for impact and for the horizontal forces produced by acceleration when slewing.

The spacing of the webs of the main girders was fixed by the gauge of the jib crane tracks with the necessary clearance for the trucks of the jib cranes. Each main girder consists, therefore, of two single-web plate girders with webs spaced at 4 ft. 0 in. centres and with common top and bottom cover plates connected to the webs by angles forming a box section. The main trolley rails are positioned centrally on the top covers and are carried between diaphragms by rolled steel needle beams riveted under the top covers. The tension members of the jib crane track hangers pass through the webs without being connected to them and are riveted through clip angles to the diaphragms.

The outreach specified for the jib cranes beyond the upstream leg was such that the leading wheels of the jib crane trucks came over the operating machinery for the upstream door. It was necessary, therefore, to cut away the ends of the track girders and the webs of the main girders for a 90° segment of a circle struck from the centre of the door roller. To simplify manufacture and erection, this was done at the downstream ends of these members as well.

The main girders, each of which weighs 42 tons complete, are connected to and supported by the two ring girders which form the main load frame of the gantry structure and carry the weight of the trolley, jib cranes, and superstructure down to the wheel trucks. Due to the fact that the jib cranes must project under the top girder of the ring at the upstream side, it was not possible to frame the trolley girders into the ring, and the bottom of the ring girder could not be placed at a lower level than the top of the trolley girders. Under these conditions, it was found that the end rotation of the trolley girders, due to deflection, if rigidly connected to the ring girders, would produce considerable secondary torsional stress in the top horizontal element of the ring girders. It was decided, therefore, to hang the trolley girders from the ring girders by links and pins (Fig. 4), and make a semi-flexible gusset plate connection between the trolley girders and the ring girders to maintain squareness of the structure in the horizontal plane and to deal with inertia loads and unequal adhesion at the wheels when travelling. This, in turn, made the trolley girders incapable of acting as the top element of a bent or portal as in normal gantry cranes and other means of connecting the ring girders together had to be adopted. These consist of two 12 ft. 0 in. deep trusses connecting the ring girders together at the outer faces of the leg sections while at the inner faces of the legs, two 42 in. deep expanded web beams are placed with butted connections to the inner faces of the vertical or leg elements of each ring. These four cross members maintain the ring girders in parallel and at their correct spacing. They also serve to support the operating machinery for the large end doors. The expanded web beams are braced horizontally to the top cover of each of the main girders and thus provide bracing in the horizontal plane additional to the gusset plates at the ring girders. This horizontal bracing system is also utilized as support for the walkways which run alongside the top covers of the main girders.

The ring girders are designed as continuous bents and are constructed of plates and angles forming a rectangular closed box section. Allowance is made in the design for the maximum vertical end reactions at the trolley girders due to the loaded trolly at its minimum end approach plus vertical and horizontal load due to the jib cranes working with full load. Inertia loads due to gantry and trolley travelling are also taken into account as in normal crane practice. In addition, the ring girder elements are designed to carry the loads due to wind, acting on the projected area of the structure. The ring girder legs, the 12 ft. 0 in. deep cross trusses and the expanded web beams, all forming the portal structure, are also designed to resist the forces due to deflection of the end doors when these are subjected to wind pressure. The catenary loads due to the deflected door curtain are transmitted to the door guides by "wind locks" and from the guides to the legs by bolts. Each ring girder weighs approximately 66 tons.

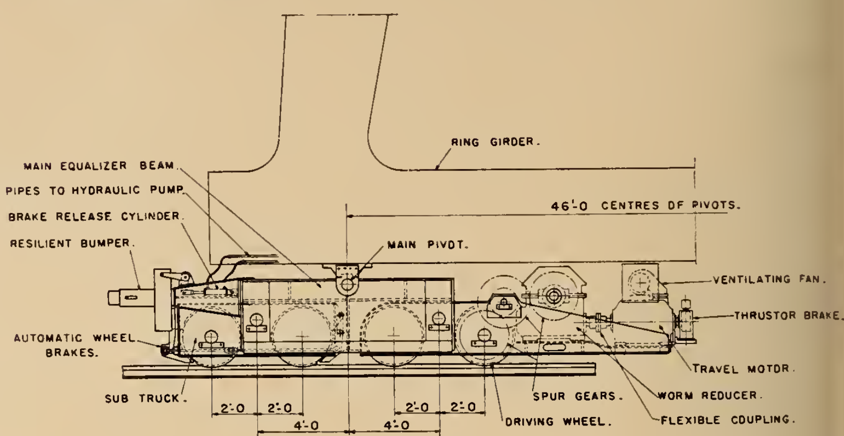


Fig. 5

Wheels and Trucks (Fig. 5)

The bottom horizontal element of each ring is carried on two steel forgings which in turn transmit the loads to the four main equalizer beams of the truck system. The design of the pivot bearings at these four points follows that used extensively on ore bridges. The forgings bolted to the ring girders each have a rectangular slot machined in their lower faces at 90° to the line of the runway rails. On the top surface of each equalizer beam a key is formed and this key fits into the slot in the upper forging. Lateral forces are catered for by a second key fitted through the forging and equalizer key and lying parallel to the track and therefore at right angles to the bearing key. The four equalizer beams are of welded construction and are bored at each end for the pivot pins of the sub trucks. They also carry the main bumpers for the end stops. These bumpers are of the resilient type in which the elastic member is a series of "Fabreeka" pads.

In order to conform to the architectural requirements, the main equalizer trucks were placed at approximately the same level as the sub-trucks, and this determined the design, which is that of an inverted U or channel section.

The sub-trucks, of which there are

eight, are each carried on two wheels. Four of the sub-trucks, one at each corner, are drivers, one wheel in each being driven. All the wheels are double-flanged cast steel, bushed with bronze, and turn on axles locked in the sub-trucks. Each driving wheel has a cast steel spur gear ring bolted to it, and these are driven through spur and worm-gears by four 35-h.p. d.c. mill motors, continuously rated with forced fan ventilation provided by separately driven fans. These motors which draw their direct current from the variable voltage motor generator set on the trolley, give a gantry travelling speed varying from 100 f.p.m. to 250 f.p.m. Each motor has a bracket mounted a.c. thrustor brake and at one truck a centrifugal overspeed switch and tachometer drive is fitted.

Wind Brakes

When a gantry crane is located in the open and is liable to be subjected to high wind pressures, safety clamps additional to the motor brakes are required to prevent accidental movement of the crane along the tracks. When the crane is a totally enclosed power-house type with very large unbroken surfaces comparable in area to those of a building, such clamps are essential and must be carefully considered in the design stages. They must be capable of preventing any skidding of the crane with the driving wheels locked and, to give the highest possible degree of protection, should be applied automatically when the crane is left unattended. They may also be interlocked with the travel motors and "dead-man" device if this is fitted.

As the runway rails in front of the erection bay are mounted flush with the concrete, and the groove in the latter was required to be as narrow as possible, it was not feasible to fit the usual vise-type of rail-clamp which grips the head of the rail between serrated jaws. Instead, a system of automatic wheel brakes was designed, incorporating the desirable feature of "failing safe."

These brakes consist of lined shoes working on the treads of eight wheels of the trailer trucks. They are applied by weights and released by hydraulic cylinders actuated by oil pressure from a motor driven vane-type pump. The wind brakes set automatically on failure of power to the crane or when the travel motors are de-energized. However, to permit of inching the gantry for final positioning of a load, a delay device is introduced into the hydraulic circuit. This consists of an accumulator of the air-oil type combined with an orifice check valve in the return line from the hydraulic releasing cylinders. These are so proportioned that the setting of the wind brakes is retarded for some minutes after the travel master switch is moved to the "off" position, allowing further small movements of the gantry to be made before the wind brakes set. As the a.c. pump motor is started as soon as the main supply switch is closed, the short time necessary for the accumulator to build up to pressure to release the wind brakes is not a drawback. When the master switch is moved to the first notch to travel, a solenoid valve is opened and the wind brakes are automatically released. Sequence switches ensure that the travel motors cannot be energized until the brake shoes are clear of the wheels, and indicator lights are provided so that if one or more of the brakes fail to release, and the gantry therefore cannot travel, the trouble can readily be

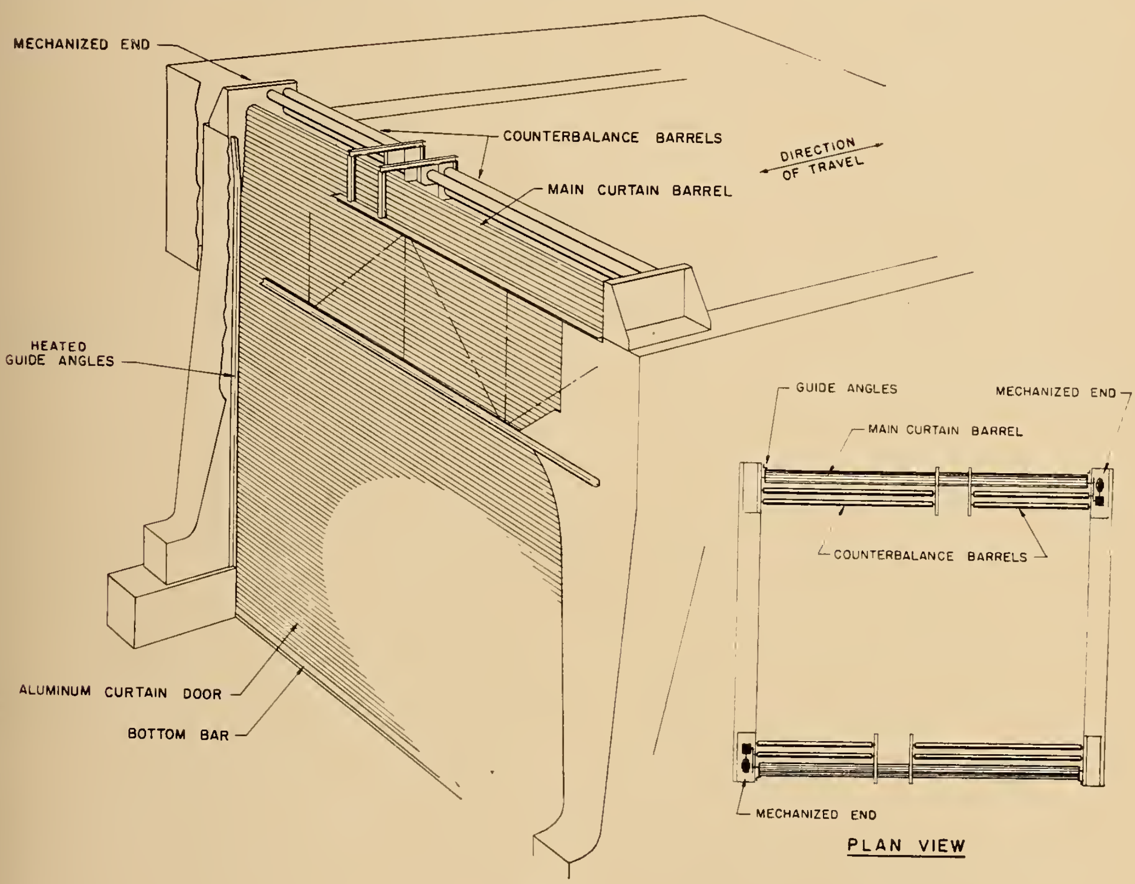


Fig. 6

localized and dealt with expeditiously.

The a.c. thrustor brakes on the travel motors operate normally when the master switch is moved to the "off" position, and as this type of brake is inherently more gentle in application than the solenoid or magnetic type, it was selected for this duty. A worm-gear drive with braking on the input shaft can produce violent deceleration from full speed in the event of a power failure with the possibility of damage to valuable loads and almost certain damage to the crane.

Enclosure and Doors (Fig. 6)

The entire upper part of the gantry crane is covered in by a steel weatherproof housing with a ridged roof. This housing was carefully designed to present a pleasing appearance and, to ensure that no stress lines or wrinkles would mar the surfaces, the two sides at right angles to the tracks are suspended from 18 ft. 0 in. deep trusses which extend the full width of the crane. The sides parallel to the tracks are supported by the ring girders and cannot deflect due to roof loads. A line of weatherproof louvres extends right around the house sides. The roof has a parapet all around it forming a gutter, and drainage to the floor level is provided by downpipes so that, if the crane should enter the heated erection bay with a covering of snow on the roof, the melting snow will not cascade over equipment on the floor.

At each end of the crane structure, the space between the legs can be closed by a vertical rolling door. These doors are constructed of interlocking aluminum slats and have a clear opening of 48 ft. 4 in. wide, by 37 ft. 6 in. high. They are electrically operated, and are interlocked with the gantry travel motion so that, until the doors have been raised to a height sufficient to clear the generator covers, only very slow-speed travelling can be carried out. This feature enables small positioning movements to be made without the need for raising the doors more than about 6 in. from the closed position so as to minimize loss of heat in winter and exlude rain or snow.

The door curtains are raised and lowered on large drums driven by electric motors and are restrained at the sides by heavy guide members bolted to the leg elements of the ring girders. These guides have electric heating for de-icing built in to prevent damage to the doors during winter operation. It may be of interest to note that, with a 100 m.p.h. wind, it is calculated that a deflection of 26 in. will be produced at the centre of the doors and that the forces tending to pull the curtain out of the guides will be of the order of 10,000 lb. per foot run. The weight of the curtains and drop-bars is balanced by a system of spring rollers geared to the curtain drum and the drop-bar incorporates a pneumatic safety device which arrests lowering if an obstruction is met with by the bottom of the curtain on its way down.

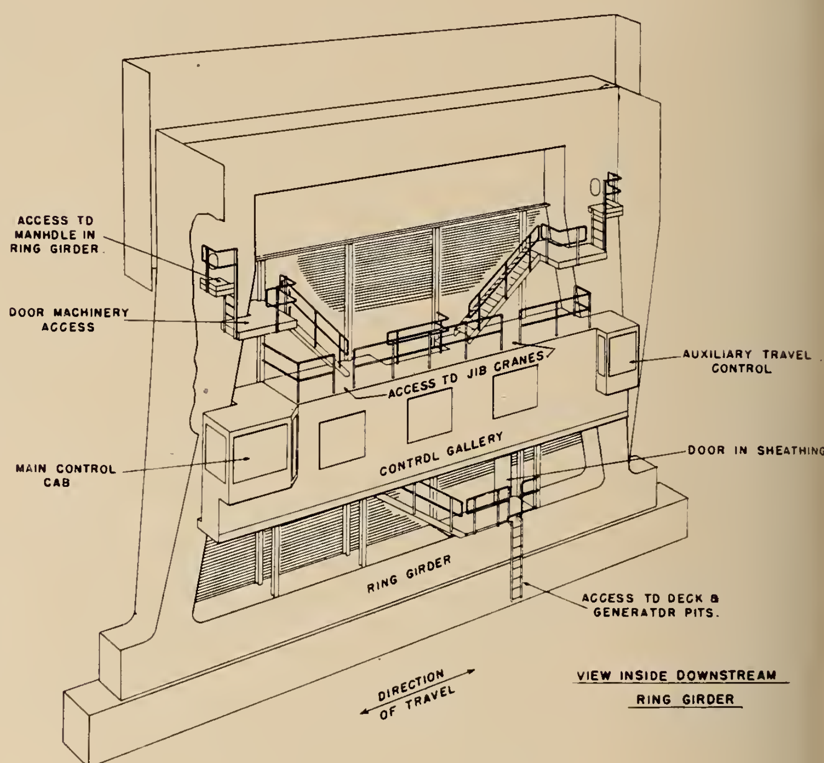


Fig. 7

The space within the annulus of the downstream ring girder is filled with aluminum slats, carried on a girt system which distributes the wind loads to the ring. The upstream annulus is closed in similarly, but, to allow the jib cranes to project beyond the upstream rail, a rolling door of similar design to the large end doors is incorporated in this face.

Control Cabs and Stairways (Fig. 7)

Access to the interior of the gantry is provided by a ladder on the downstream face of the enclosure leading up to a door at the top of the bottom horizontal element of the ring girder. From the top of the ring girder, a stairway leads up to an enclosed gallery which extends across the downstream ring girder parallel to the tracks. This gallery contains all the contactor equipment and resistors for the variable voltage d.c. generator together with the main and auxiliary a.c. contactors and starters. The height of the floor of this gallery was determined by the clearance required over the equipment in the erection bays, while the roof is utilized as a landing in the stairway leading to the upper walkways an as a means of access to the jib cranes. Platforms are provided at the uppe levels where necessary to facilitate in spection and maintenance of the doc machinery units, while manholes an ladder rungs give access to the insid of the ring girders during erectio and for painting.

The main control cabin is situate at one end of the enclosed galler Its dimensions were largely dete mined by the clearances required pass equipment positioned on t floor of the American erection ba at the same time providing space f the master switches and control co sole for the main motions of the cran In these large power-house gantrie the size of the crane structure ar its enclosure make it necessary f two positions to be provided from which the gantry travel motion may be controlled, and it is desirable that each of these positions should be as near as possible to the leading faces of the crane for each direction of the motion, so that the operator has a clear view of the deck ahead of him. The position of the main control cab as described fulfils this condition for one direction of travel and by placing the auxiliary control cab at the other end of the gallery, a favourable position for the opposite direction was obtained. By placing the travel master switches so that the operator faces down the track when manipulating them, the best position for vision under the partly raised doors seemed to have been automatically chosen so that this part of the design presented fewer difficulties than seemed at one time likely, in view of the size of the machine. Both control cabs are built with insulated walls and have sliding and fixed windows glazed with Thermopane.

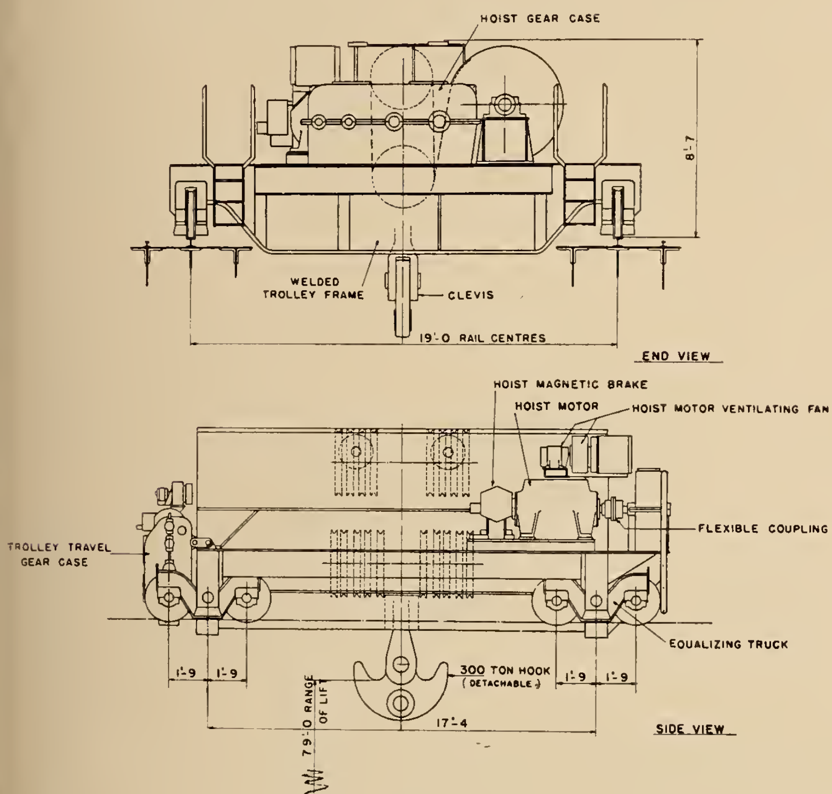


Fig. 8

Shop Fabrication and Field Erection

The gantry was too big for complete indoor shop assembly and, as the later stages of fabrication were in progress during the winter, outdoor shop assembly was also ruled out. In order to facilitate field erection, all the main connections and splices were therefore template reamed, and partial erection was carried out in the shops to prove the main connections in the ring girders. The top horizontal elements of these were also set up and the main girder pin and link connections with the plan bracing gussets tried in place in the shops. The truck assemblies were also completely assembled as units in the shops, but final alignment of these is left for the field, the main pivot bolts being subdrilled for field reaming. Each equalizer has four surfaces machined at a predetermined distance from the rail centre and these surfaces are used for aligning the trucks before reaming the pivot bolts to the bottom ring girder elements. Both ends of the connections on the expanded web cross beams were faced so that these members may be used as squaring and plumbing gauges at the top of the ring girders.

Main Trolley (Figs. 8 and 9)

The main trolley is a single hoist type of 300 tons capacity. The sister or ramshorn hook is pin connected to a forged steel clevis which rotates on a ball thrust-bearing. This bearing is carried on a forged steel crosshead which swivels in the block side plates. All the sheaves run on anti-friction bearings. The load is lifted on 20 parts of 1⅜-in. diameter, improved plow, galvanized steel wire rope, two parts of which wind on a 60-in. diameter welded steel grooved drum with trunnions welded integral with the body and machined to run in bronze bushed bearings. A single steel spur gear is fitted to one end of the drum and is driven by spur gear reductions from a 125 h.p. d.c. mill motor, giving, by means of the variable voltage control, speeds varying from 5 f.p.m. with full load to 15 f.p.m. with no load on the hook. The motor has forced fan-ventilation and as the d.c. supply provides dynamic braking lowering, no mechanical load brake is fitted. A d.c. magnetic brake is mounted on the motor shaft. The high speed gears are enclosed in a gear case welded integral with the trolley frame and run on bronze bearings. The trolley runs on eight double flanged cast steel wheels mounted in pairs in equalizing trucks which are pivoted to the trolley frame. A 12½-h.p. d.c. mill motor with forced-fan ventilation drives two of the wheels through spur gears and gives a rated trolley travel speed of 20 f.p.m. The trolley frame is built up of welded steel sections bolted together and is arranged for partial dismantling for shipment. The frame consists of two girts, one of which carries the hoist gear case, connected by beams which support the head and equalizer sheaves. The deck plate with its stiffeners serves to keep the trolley square and carries machined pads on its upper surface for the hoist motor and brake. In addition, the motor-generator set with its exciters is mounted on the trolley. Power is conveyed to the trolley and from the m.g. set to the gantry travel motors through a series of flexible cab-tire cables hung on "messenger" wire ropes, giving a series of loops which expand and contract, like a concertina, as the trolley travels away from or towards the junction-box at one end of the girders where the cables terminate. This system, which eliminates sliding contact shoes, was made possible by the short travel (25 ft.) of the trolley.

Service Gantry (Fig. 10)

In order to provide means of removing and lowering to the deck any part of the main trolley machinery which might require servicing, a small gantry crane of 13 tons capacity is mounted on the trolley girders and runs on rails positioned over the webs of the outer members of these girders; that is, outside the trolley rails. The gantry consists of two vertical end frames, each carried on two double-flanged roller bearing wheels, and is arranged for push travel. These frames are connected at their upper surfaces by two rolled steel beams inside which a sheave block trolley runs, also on roller bearing wheels. The hoisting gear, carried on one end frame is driven by a 5-h.p. 900 r.p.m. squirrel-cage electric motor and has a hoisting speed of 5 f.p.m. The load is lifted on 4 parts of 7/16 in. diameter wire rope which is led double from the drum up over sheaves at the top of the end frame, over two sheaves on the trolley, through the hook block, and over two more sheaves on the trolley, to an anchorage on the opposite end frame. All sheaves have ball bearings so that, by pushing the load, the trolley may easily be traversed across the gantry. The single-speed hoist motor is operated by push-buttons and a reversing starter and overhoisting limit-switch protection is provided. An electric brake is fitted to the motor but no mechanical load brake is provided, as the squirrel-cage motor gives regenerative braking when lowering. Current is conveyed to the gantry by a trailing cab-tire cable.

Conductor System

The conductor systems consist of copper angle busbars supported by insulators and hung from steel brackets bolted to the switch-gear building and to the walls of the erection bay. A dished cover of aluminized steel sheet provides continuous protection over the whole length and is free to expand or contract with reference to the supporting steelwork. Expansion joints are also provided in the copper angles.

Special Equipment

Provision is made at each bottom corner of the ring girders for insertion of a heavy needle beam if it should be necessary to jack up one corner of the crane. If trouble such as a seized wheel bearing should occur, a sliding shoe is provided, which can be used as a skid to avoid rubbing a flat spot on a tight wheel while moving the crane to a position where repairs can be effected. In order to service the slip-ring collectors on the jib cranes, a portable platform can be hung on the front face of the control gallery and moved in line with either jib crane. The jib crane to be serviced is then travelled or towed to the end of its track, when the slip ring is easily accessible from the portable platform. This device may also be used for cleaning the windows in the control gallery and in the cabs at either end.

General Remarks

As this crane is the largest of its type to have been built in Canada, some general statistics may be noted. Without its load, the crane complete weighs about 600 tons, of which 470 tons are structural steel. Excluding the motor generator set, the crane uses 25 electric motors, varying in size from 200 h.p. to 1/3 h.p., with an aggregate of 500 h.p. The motor-generator set for the d.c. supply has an output of 125 kw., and the set itself weighs 4 tons. The main hook block weighs 12½ tons, and the main hoist ropes have a breaking strength of 1620 tons, giving a factor of safety of 5.4 to 1 on the rated load. The length of the two conductor systems together is in excess of 3,000 feet, and with no load on the hook, the crane can traverse this distance in 12-15 minutes. The range of lift of the main hook is 79 ft. 0 in.; that of each of the jib crane hooks is 92 ft. 0 in. Separate centralized lubrication systems with manual pumps are provided for each drive truck, each jib crane slewing portion and each jib crane truck, for the main trolley, and for the service gantry.

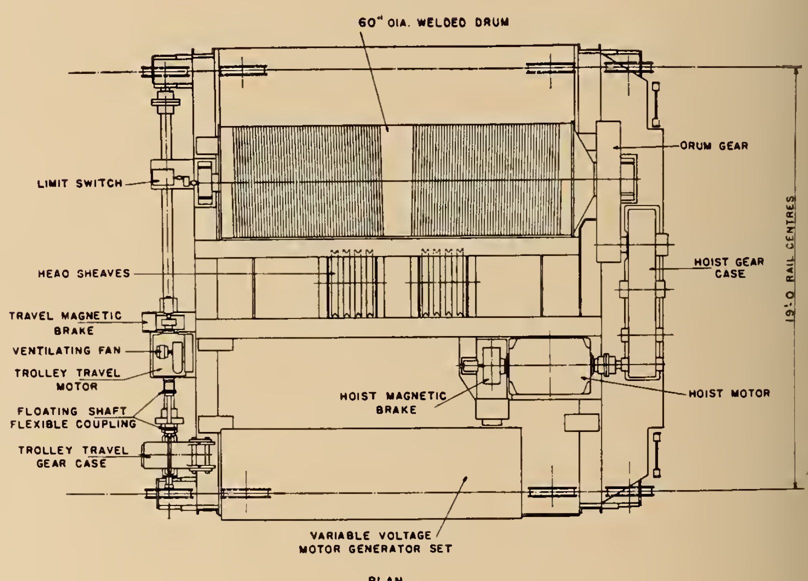


Fig. 9

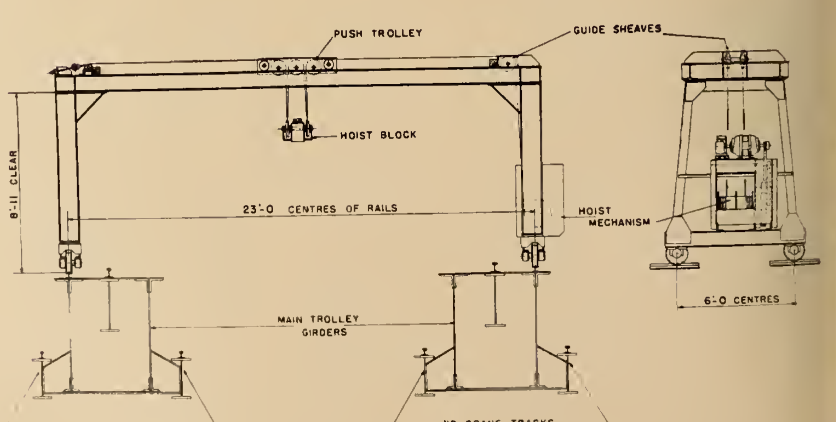


Fig. 10

St. Lawrence Seaway Locks

(continued from page 1434)

to bias the magnetic amplifier to zero output. The pattern winding is connected through a variable resistor to give any fixed effect on the magnetic amplifier. The damping winding controls smoothness of the amplifier output and the speed winding is connected through a rectifier to the stator of the pilot generator. The pilot generator output voltage opposes the effect of the pattern voltage. Thus, for any preset value of pattern current, there will be a definite motor speed corresponding to the voltage applied to the motor. An output winding supplies the net signal to the reactors. This control system gives a set of speed torque curves similar to those of an unregulated d.c. system, and is adjustable over a speed range of 10% to full speed.

The controls are also arranged so that, in the case of failure of any part of the reactors or reactor control system, the motor may be operated as a conventional wound rotor motor.

Drive Application

At Iroquois, the sector gates must be operated under a 24.5 ft. head during the construction period. To keep the hydraulic surge in the lock as small as possible, the gates must be opened very slowly (10% speed) for the first 3 degrees, then stopped for a given period of time until the water reaches a specified level, then started up slowly again (10% speed) for a short distance, speeded up to full speed until nearly opened, and finally creeped into the fully open position (10% speed).

At the upper Beauharnois and Cote Ste. Catherine locks, when the sector gates are used to shut off the canal in the event of a free flow condition arising, they must be closed very slowly, i.e., at approximately 10% of normal speed, in order to keep the hydraulic surge to a minimum. Under normal operation, they will be operated at the same normal speeds as the mitre gates.

The mitre gate drives will be adjusted to start the gates at a very slow speed (10%), then drive them at maximum speed and finally creep them into the final position.

As the operating head differs considerably from lock to lock, the valve opening speeds must be varied accordingly in order to control the surges. These operating times vary from a minimum opening of approximately 2¼ minutes at St. Lambert lock to a maximum opening time of about 8 minutes at the Beauharnois locks. The closing time for all valves is about one minute, and this represents full speed of the motor.

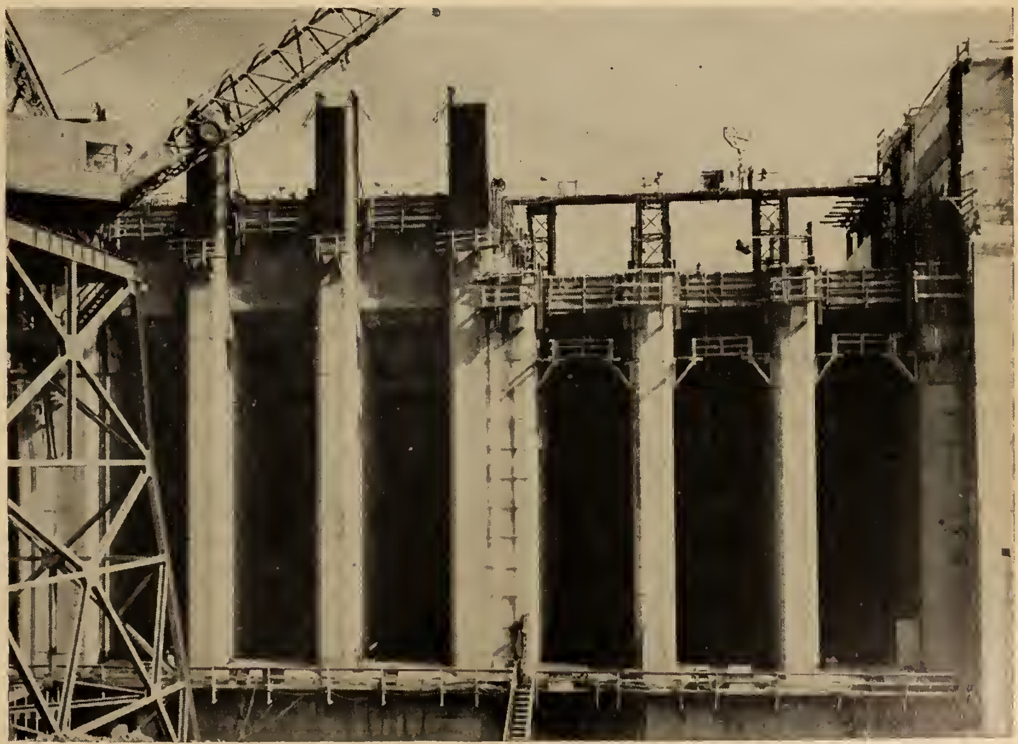
The fender raising and lowering operation is similar to the mitre gate operation, that is, the fender starts slowly (10% speed), speeds up to maximum speed over most of its travel, and creeps into its final position (10% speed). A creeping slowdown speed is necessary to prevent whipping of the fender boom.

By the adoption of the reactor type control system described in the foregoing, enough flexibility is attained to meet the varying speed requirements of all the machinery on the Seaway locks, thus making possible the adoption of one motor rating for all valves, fenders, and gates.

Operation of the lock gates, valves, and fenders can be made from either local or remote control points. For remote controls, all operation is from control desks located in control rooms, one being for all operations at the upper end and the other at the lower end of each lock.

The water regulating gates are also controlled remotely from these desks, the gate position being indicated on the control desk by means of a Selsyn indicator.

The stiff leg derrick is operated by means of a 75 h.p. splash-proof squirrel cage motor controlled by a general purpose combination type starter arranged for operation from a remote push button station.



ST. LAWRENCE POWER DAM

A view of the water intake portals for the St. Lawrence Power House.

(Photo: Power Authority State of New York)

Montreal Area Bridge Alterations for the St. Lawrence Seaway

P. G. A. Brault, M.E.I.C.

Design Engineer, Eastern Division, Dominion Bridge Company Limited

Four bridges, crossing from the Island of Montreal to the south shore mainland, require modification to provide navigation clearance over the Seaway canal. This paper describes the four bridges, the solutions adopted to provide canal clearance and the proposed operations involved to accomplish the amendments.

A VESSEL SAILING upstream through the Seaway would first pass the Jacques Cartier highway bridge shortly after entering the canal. About two miles further on, it would pass the Canadian National Railway's Victoria bridge and enter the St. Lambert lock. Leaving this lock, it would proceed about ten miles to enter the Cote St. Catherine lock, thus by-passing the Lachine rapids. After a further five miles of travel, it would reach the Honoré Mercier highway bridge, and, some four hundred yards beyond, it would pass the Canadian Pacific Railway's Caughnawaga bridge and into Lake St. Louis.

What alterations are necessary to each of these bridges to permit such a sailing and how these alterations are to be accomplished, is the subject matter of this paper.

JACQUES CARTIER HIGHWAY BRIDGE

Only that portion of the bridge between St. Helen's Island and the south shore is affected by the Seaway. This part consists of a series of simple deck truss spans from abutment no. 0 to pier no. 18. From the south abutment no. 0 to pier no. 3, there are three 125-foot spans; from pier no. 3 to pier no. 7, there are four 150 ft. spans from pier no. 7 to pier no. 9, there are two 200 ft. spans, and from pier no. 9 to pier no. 18, there are nine 250 ft. spans.

The Seaway canal, 180 ft. wide, passes between pier no. 9 and pier no. 10, and at an angle of about 85 degrees to the axis of the bridge. The roadway grade is 3.1 per cent upwards from abutment no. 0 to pier no. 7 and 1.0 per cent upwards from pier no. 7 to pier no. 18.

In cross-section, the deck trusses are 40 ft. 0 in. centre to centre, and support transverse floor beams cantilevered 16 ft. 6 in. either side. These floor beams carry a 36 ft. 10 in. concrete roadway slab on longitudinal stringers, two rapid transit-ways, 11 ft. 10 in. wide and two 5 ft. 6 in. wide sidewalks, all arranged symmetrically about the centreline of the bridge. The overall depth of the 250 ft. spans from roadway surface to underside of bottom chord is about 43 ft. 3 in., with chords at 35 ft. centres. Both ends of each span are provided with a jacking girder adjacent to the bottom chords and they are designed to support the full dead load at 50 per cent increased unit stresses. The jacking point locations are four feet inside from each truss centreline. Recently, the downstream transit-way has been converted into a roadway widening thus increasing the dead load on that side. It was found that the jacking girders had to be reinforced for bending moment although the shear connections were adequate.

Span no. 10 clearance over the canal is obtained by first replacing the existing deck span by a through truss span. In this manner, the depth from roadway surface to underside of truss chords compared with that of the deck truss gains about 35 ft. The balance of the 120 ft. clearance required is obtained by sufficiently raising the floor level. This means that roadway level at pier no. 9 has to be raised 50.52 ft., and at pier no. 10, 48.00 ft. This difference is due to the decision to make the roadway elevations the same at both piers and eliminate the existing 1.0 per cent grade in span no. 10. Joining the new roadway elevation at pier no. 10 to the existing roadway elevation at pier no. 14 produces a grade downwards of 3.8 per cent. Since at pier no. 14, this grade joins the existing upward grade of 1.0 per cent from pier no. 14 to pier no. 18, a vertical easement curb is necessary. This easement is obtained by amending the floor construction on the four adjacent panels of each truss supported on pier no. 14. From pier no. 9 to abutment no. 0, a maximum downward grade of 4.2 per cent, dictated by winter conditions, is adopted. This means that the roadway elevation at abutment no. 0 is 26.83 feet higher than the existing elevation. Since the new bridge approach consists of a fill, the extended abutment no. 0 is not capable of retaining the added horizontal pressure. Consequently, an additional abutment no. A, south of existing abutment, is introduced for this purpose.

A new 65 ft. deck span on the 4.2 per cent grade is provided between the old and new abutments.

To permit increasing the height of abutment no. 0 and construction of abutment no. A, it is necessary to divert traffic off the existing roadway. The turn-offs are located on both upstream and downstream sides of the bridge at the south end of span no. 3. They are timberdecked steel platforms supported on braced columns and each platform is connected to temporary turn-off fills by pairs of Bailey bridges. These pairs of connecting bridges, producing two 12 ft. roadways on each side, consist of two 110 ft. spans made of triple double bridging, and one 80 ft. span of triple single bridging, all supported on steel bents.

With traffic diverted, thus freeing span no. 1 and span no. 2, the first of five stages of jacking can be undertaken. In this first stage, the south end of span no. 1, on abutment no. 0 is raised to its new final elevation and the north end on pier no. 1 is raised about 13 feet. The south end of span no. 2 on pier no. 1 is also raised about 13 ft., while its north end, on pier no. 2, is kept unchanged.

Keeping in mind the necessity of equal jacking of ends of adjacent spans resting on a pier, it is not possible to jack at pier no. 2, while the turn-off is in service. To do so, it is necessary to re-route traffic onto the bridge after completion of abutment no. A, and the new 65 ft. approach span. This means that, temporarily, northbound traffic would have to negotiate a 4.2 per cent upward grade on the approach, a downward 7.5 per cent grade on span no. 1 and span no. 2, and a 3.8 per cent upward grade from pier no. 2 to pier no. 7.

Stage no. 2 jacking will raise the floor elevation at pier no. 10, by 10.68 ft., and at pier no. 9 by 13.20 ft. This brings span no. 10 to a level grade and is an arbitrary decision to locate the position to construct the new through span. It represents an estimated equality of time required to erect the new span and the time required to complete stage no. 2 jacking. The roadway surface will be brought to its final elevation at pier no. 13, with a straight line maintained between pier no. 10 and pier no. 13. There will be no jacking at pier no. 7, and the roadway kept in a straight line from pier no. 7 to pier no. 9. This stage will locate span no. 14 in its final position.

Stage no. 3 jacking will bring the roadway surface to final elevation at piers nos. 1 to 5 inclusive, with a straight line maintained between pier no. 5 and pier no. 9. This stage will locate spans nos. 1 to 5 in their final position.

After removal of the existing deck span no. 10 and the simultaneous positioning of the new through span no. 10 on centreline of bridge, stage no. 4 jacking can proceed. This stage will raise span no. 10 by 19.32 ft. and the floor level at piers nos. 6, 7, and 12 brought to final elevation; thus spans 6, 7, and 13 will be brought to their new permanent location.

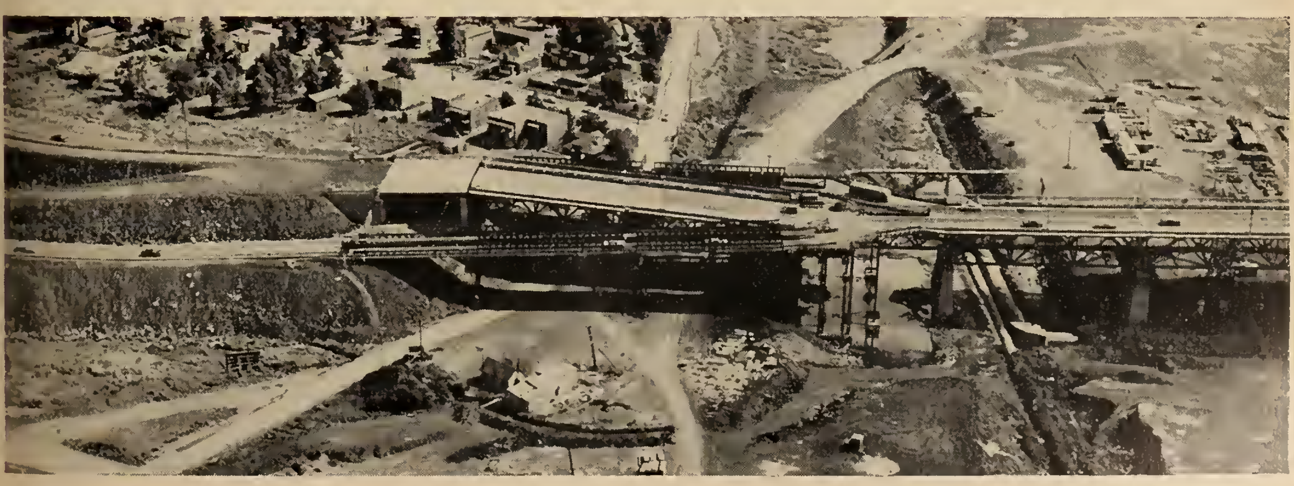
Finally, stage no. 5 will raise span no. 10 by a further 18 ft. providing the desired canal clearances and spans nos. 8, 9, 11, and 12 brought to final revised positions.

Since, during jacking operations it is required that traffic be maintained on the bridge, it is necessary that the ends of both spans resting on a common pier be raised equal amounts at each operation. The jacking arrangement has to be such that when not in use, all load reactions could be resisted. To this end, a device referred to as a climbing jack was developed. It consists of a weldment made of two parallel plates cut into an inverted "U" shape with a heavy bearing plate across their tops and bearing plates across the bottom of each leg. The two plates are thoroughly diaphragmed in way of the two legs. The weldment is so proportioned that a hydraulic jack may be inserted in an inverted position between the legs, with the ram downwards and the jack base in contact with the upper cross-bearing plate.

A normal operation consists of a 6 in. runout of the ram, thus raising both bridge and weldment. Six-inch precast concrete blocks are then inserted under each leg between the bearing pad and the pier. A threaded follow-up nut on the ram is provided as a precautionary measure. With the ram fleeted, a block can be inserted under the ram and the operation repeated.

For stability, as a pier member when not in use for jacking, an adjustable strut connects the lower part of the climbing jack to the truss bottom chord, one panel away from the end bearing. These struts are loosened during the actual jacking.

Fig. 1. Jacques Cartier Bridge turnoffs. New abutment and 65 ft. span in place. Stage one jacking of spans No. 1 and No. 2, nearly complete.



The climbing jacks are of two types; fixed and expansion, the expansion type having lubrite bearings under the leg pads. An arrangement is devised to lock the movement when jacking occurs at the far fixed ends of the span. Climbing jacks are permitted to rest on a maximum pile of four 6 in. blocks after which all jacking must cease until a 2 ft. pour of the pier extension has been completed.

During the winter months, special curing precautions are taken and an elapsed time of 60 hours is required before further jacking. This elapsed time is about 48 hours during the summer season.

Eighteen 500-ton hydraulic jacks and twelve 400-ton hydraulic jacks will be used for approximately 940 six-inch lifts required to complete the project.

About 30 inches of preliminary jacking of spans is required in order to insert the climbing jacks. This is accomplished by jacking 6-inch increments on the jacking girders and placing precast concrete blocks under the present pier members. At the proper height, both blocks and pier members are removed and replaced by climbing jacks. Stability conditions plus inadequacy of the jacking girder to carry live loads compelled a brief stopping of bridge traffic in early morning hours to perform this operation. At the final span elevation, these operations will be in reverse, with the necessary blocks and the original pier member replaced while the span is jacked on the jacking girders.

Each pier is surrounded by a working platform suspended from the adjacent steel spans, thus remaining in proper working position as jacking proceeds at that pier. Since the rotation of a span due to a six inch rise at one end will close the roadway gap at the other end by about one inch, a careful sequence of jacking is necessary to avoid gap jamming. The jacking sequence is also developed to provide, as much as possible, continuity of the 2 ft. pier pouring operations.

The new 250 ft. through span no. 10 consists of two 8-panel camel-back trusses, 66 ft. centres and 40 ft. deep at centreline. Panel point truss floor beams carry framed longitudinal stringers which support the 60 ft. roadway slab. Cantilevered brackets on each side support the 5 ft. wide walkways.

The through span is to be erected on timber falsework on a position 78 ft. upstream from the centreline of the existing bridge, with the roadway slab at the same elevation as the slab in the existing no. 10 deck span when stage no. 2 jacking is complete. In this manner, when the new span is translated into position, the bridge can be put immediately into service.

Preparation for the erection of the new span involves:

(*a*) Erection equipment
(*b*) Translation runway
(*c*) Timber falsework

A traveller will be used to erect the truss steel. It will consist of a 20-ton stiff-leg derrick mounted on a truck-equipped structural platform located immediately south of the new span at a level suitable to runout on the new floor steel. A 90 foot high timber falsework tower from the top of the canal guard pier will be required to support this initial traveller position.

The location in plan and elevation of the translation runways is governed by the position of the bearings of the existing deck span no. 10, after completion of stage no. 2 jacking. Each runway consists of seven parallel 85-pound rails at 6.5-inch centres supported on the 78 ft. length of pier and extending 77 ft. upstream and 65 ft. downstream from the pier ends.

On the extensions, the rails are supported by 3 in. deep, 6 in. wide, steel ties carried on four 30 in. deep rolled beams at 13 in. centres. The beams in turn are supported by batter-posted timber bents at 10 ft. 6 in. centres resting on the guard piers. The timber bents are about 44 feet in height.

The timber falsework panel point bents on which the new truss span is to be erected extends from the canal bed to underside of bottom chord, a height of about 138 feet. Special concrete footings will be poured and alternate bents shear-braced longitudinally with thorough strutting between the unbraced bents. From the underside of the new span pier members to the top of the translation runways rails is about 32 feet. The pier member reactions must be supported at the runway level, not only for translation, but also for the future jacking operation, as this level is also that of the adjacent span climbing jacks. Transversely braced steel posts will therefore be added and erected as part of the truss with the bottom of each post strutted with a diagonal

Fig. 2. Jacques Cartier Bridge Span No. 10. Falsework and traveller in place for erection of the new through span.

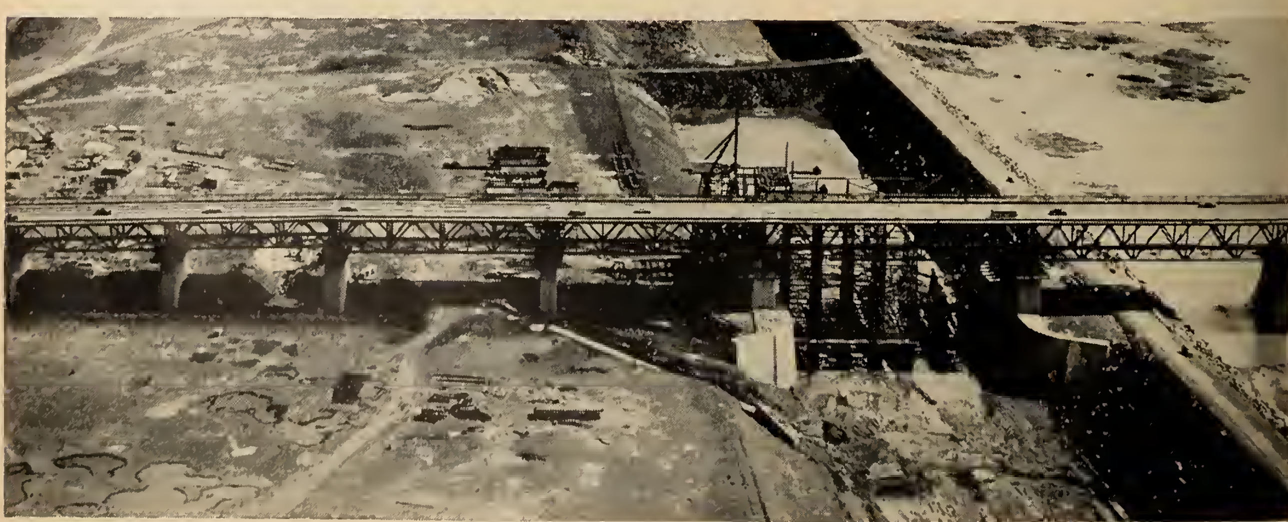


Fig. 3. Victoria Bridge, showing span No. 25 in way of St. Lambert Lock under construction.

member to the following bottom chord panel point.

The traveller will erect floor and bottom chord steel moving forward panel by panel. Upon reaching pier no. 10, it will back up panel by panel, erecting the truss members and overhead bracing. It will finally move back upon the staging on which it was originally erected and both traveller and staging dismantled.

With the steel dead load transferred off the falsework to the end bearings, slab forming and pouring will proceed. At the same time, the erection falsework will be removed.

After some 30 days of slab curing time, translation of the new span no. 10 for the old deck span will be undertaken. The four span bearings in way of each translation runway will be supported on roller nests engaging the rails and connected to each other by plate ties. At the downstream end of each runway, there will be a fixed bearing head securely connected to the rails. A horizontally positioned 300-ton hydraulic jack, with a 4 foot runout, will bear against this head with its ram bearing against a movable head connected to the downstream roller nests by a series of 4 foot long pinned links. With each 4 foot runout of the jack ram, both the old and new spans will be translated four feet. With a link pin withdrawn and a 4 foot link removed, the jack will be flected, links re-pinned and operation repeated until the full 78 feet of translation is accomplished.

With the climbing jack inserted under the new span translation bearings, the jacking of stages nos. 3, 4, and 5 will proceed. When the new span is at its final elevation, the inner halves of piers nos. 9 and 10 will be poured to the underside of the permanent pier members, thus encasing construction posts. The stability strut will then be removed.

During these final operations, the translated existing deck truss span no. 10 will be dismantled.

VICTORIA RAILWAY AND HIGHWAY BRIDGE

Victoria Bridge, owned and operated by the Canadian National Railway, crosses from the Island of Montreal to the south shore at St. Lambert. It consists of 25 double-track railway through-truss spans with floor beams cantilevered to carry a 16 foot roadway on each side. All spans are pin connected. The centre span is 348 feet long and the 12 spans, both ends of the centre span, are all identical Pratt type trusses 254 feet long. From the abutment to the centre span, the bridge has an upward 0.77 per cent grade. The 254 foot spans have 10 panels with trusses 31 ft. 2 in. and parallel chords at 40 foot centres. These spans have an unusual floor framing at the piers. In way of each truss, a grillage of seven beams straddles the width of the pier and support the truss end bearings. The transverse end floor beams, at about 19′ centres, connect to the ends of the two sets of grillage beams.

The centreline of the present Seaway canal passes through the most southerly span between pier no. 24 and the abutment at a point about 110 feet from the centreline of pier no. 24. This span is generally referred to as span no. 25. The canal, in this region, is 80 feet wide, being the entrance to the Seaway's first lock, 900 feet long. It is anticipated that, in the future, a second lock will be constructed, parallel and south of the present lock, about 85 feet away.

In order to provide for the 120 foot clearance over the canal, and, at the same time, provide uninterrupted highway traffic and eventually uninterrupted railway traffic, two vertical lift bridges are to be built; one, in way of and replacing span no. 25, and the other, some 1200 feet upstream, just beyond the upper lock gates. Permissible railway grades make it impossible to consider any high level arrangement as a solution. The new bridges are referred to as the lower and upper vertical lift bridges. The lower bridge actually consists of a lift span, 107 ft. 7 in. centre to centre bearings, with centreline located on the canal centreline, a 47 foot approach span on the north side, and 46 foot plus a 43 foot approach span on the south side, the whole making up the 254 foot length of span no. 25 to be removed.

The word "span" above refers, in each case, to a railway deck girder span, 6 ft. 6 in. each side of the bridge centreline and a highway deck girder span about 30 feet each side of the bridge centreline.

The new supporting pier no. 25, will be built on the north lock wall, while piers no. 26 and 27 will be built on the south lock wall.

Each end of the lift span will be carried on loading girders. These will be connected to the counterweights by wire ropes passing over 15 foot diameter sheaves on top of transversely braced posts in the form of a bent on piers nos. 25 and 26.

Fig. 4. Honore Mercier Highway Bridge and Canadian Pacific Railway bridge near Caughnawaga. Highway turnoff in operation. New piers for both bridges under way.

The tops of the posts will be connected by an overhead bridge supporting the operating machinery. The centreline of counterweight sheaves are 160 feet above the base of rail and 244 feet above the canal bottom. The lift spans will be raised 97 feet to provide the navigation clearance. On pier no. 27, 46 feet south of pier no. 26, another counterweight sheaves post will be supplied at this time, in contemplation of a future lift span over a proposed second lock. The bents at piers no. 26 and no. 27 are braced longitudinally to form a stiff tower and through the overhead bridge will impart stability to the bent on pier no. 25.

The approach span between piers no. 26 and no. 27 is referred to as the tower span. The bridge is completed by the 43 foot approach span between pier no. 27 and the existing south abutment.

The upper vertical lift bridge consists of a 96 foot lift span in way of the lock, a 54 foot tower span immediately south, followed by a 116 foot approach span, so designed, that it may be converted to a lift span when the future lock is built.

The counterweight sheave post bents, overhead bridge, tower bracing, operating machinery, etc., are all similar to the lower vertical lift span. The spans, however, are quite different. They consist of double deck Warren type trusses, with double track railway at the top chord, and 4 highway lanes at the bottom chord, 2 between trusses, and 1 outside each truss.

Dismantling the existing span no. 25 and erecting the new lower bridge, while maintaining railway traffic at the same time, presents some unusual problems. As train crossings average about 120 per day, the railway authorities permitted single track operations for limited periods only, otherwise, double track operation is required.

Before any work at all can be started, it is necessary to divert the highway traffic off span no. 25. This will be accomplished at the north end of span no. 24. Southbound traffic on the upstream roadway will make a right turn onto the embankment north of the north lock wall. This road will lead to a temporary canal crossing, some 300 feet west of the upper bridge site. Northbound traffic will proceed on the same embankment, pass under the existing span no. 24 and ramp up a 360 degree loop on to the downstream roadway of the existing bridge.

These turn-offs will be permanent arrangement for use when the lower bridge lift span is open for Seaway vessels. At that time, that will lead to the upper bridge roadways instead of the temporary crossing.

The limited time of single track operation suggests handling each track span as a unit. These heavy lifts (about 100 ton maximum), together with the high lifts required to position the counterweight sheaves, led to a decision to use the 150 ton guy derrick with a 202 foot mast and a 180 foot boom located to reach all pertinent parts of the bridge. To do so, the guy derrick will be erected on a structural steel four-posted tower, 8 feet square and 184 feet high, with base 65 feet downstream from the bridge on the floor of the lock. The hoisting and swinging engines will also be located on the canal bottom.

The top of the structural tower will be supported by four guys and the top of the derrick mast by eight guys. The guys will be connected to previously constructed deadmen located to provide guy clearance over the existing structure.

The erection of this handling equipment is, in itself, a major undertaking.

With the highway traffic diverted, the procedure to erect the lower bridge will be as follows:

(1) Remove the roadway floors and cantilevered brackets on both sides of span no. 25.

(2) Place steel falsework under the railway track floor beams. On the north and south lock walls, this falsework will consist of triple posted braced bents. In way of the lock, it will consist of three braced trusses with top chord panel points opposite the existing floor beams. All falsework will be designed to support Cooper E60 loading.

On each falsework bent, one post will be on the centreline of the bridge and the other two, 13 ft. 10 in. each side of centreline. The three trusses spanning the lock will occupy similar transverse positions. This arrangement will permit removing one existing track and one row of supports, thus leaving two rows of supports for the remaining track still in service. The falsework will be erected 2 inches clear of the existing floor beams to permit truss deflections until the load transferring operation is performed.

(3) With traffic on both railway tracks stopped for an estimated three hours, wedge floor beams at all falsework points of support.

(4) Dismantle the truss chords, diagonals, verticals and overhead bracing of the existing span no. 25.

(5) Erect the first tier of counterweight sheave posts at piers 25, 26, and 27, and connect with the base girder struts. These box struts will later support the end bearings of the adjacent approach track span girders. Erect also the end span-locks and the loading girders 7 ft. 6 in. south of bent no. 25 and 7 ft. 6 in. north of bent no. 26.

(6) Erect the upstream approach track span between the existing south abutment and bent no. 27. This procedure will be similar for the erection of all other approach track spans, as well as the lift track spans proper.

(*a*) Pre-assemble and rivet the span girders and bracing.

(*b*) Stop railway traffic on the upstream track and establish single track operation on the downstream track.

(*c*) Remove existing stringers of the upstream track.

(*d*) Cut existing floor beams on the upstream side and close to the centre falsework support and remove upstream portion. Remove also the upstream row of falsework.

(*e*) Place new span in position.

(*f*) Place ties and rails and resume double track operation.

In all cases, the rails will be laid by the railway personnel.

(7) Erect all remaining track spans.

(8) Erect the 2nd tier of bent posts at piers nos. 25, 26, and 27 together with portal struts and longitudinal tower bracing between bent no. 26 and bent no. 27.

(9) From the bent portal struts, suspend eight rows of Bailey bridging 230 feet long. This bridging will support a solid mat 36 feet wide, made of 12 x 12 timbers at 12 inch centres, thus providing complete protection of the railway tracks from overhead erection hazards.

(10) Erect the remainder of the tower bents, overhead bridge, counterweights, counterweight sheaves, operating machinery, etc.

(11) Erect the upstream and downstream highway spans.

(12) Remove the Bailey bridging overhead protecting structure, connect counterweight ropes, balance chains, etc., to complete the bridge.

Since the site of the upper bridge is not impeded by traffic, the erection problem is mainly one of handling equipment to reach the counterweight sheaves some 200 feet above the lock walls.

Two 20-ton guy derricks each with 120 ft. mast and 80 ft. boom will be used. Each guy derrick will be supported on a four-posted structural steel tower 7 feet square and 90 feet high; one located on the north wall on the upstream side of the bridge, while the other will be on the south wall on the downstream side of the bridge. Each tower top will be supported by four guys and the top of each mast by eight guys.

The tower span and the south approach span will be erected on blocking from the lock wall and adjacent terrain. The lift span will be assembled on lightweight welded erection trusses spanning the lock.

HONORE MERCIER HIGHWAY BRIDGE

This bridge crosses the St. Lawrence River from the Island of Montreal, at Ville La Salle, to the south shore near Caughnawaga. The steel superstructure consists of nine simple deck truss spans, followed by a 235 ft.-400 ft.-235 ft. continuous tied arch at the southern end. The south approach is overland and consists of twenty-five 50-foot concrete deck girder spans, of welded steel-concrete composite construction. In cross-section, the steel bridge carries a 27 ft. wide level grade roadway slab and one 4 ft. 6 in. sidewalk on the upstream side. At the south end of the south approach, the highway turns either west or east. About 300 yards from the centreline of the bridge, the westward highway passes through a narrow tunnel-like underpass under the 60 foot high Canadian Pacific Railway embankment. The eastbound highway, however, is clear of the embankment, and is roughly parallel to it.

The Seaway canal intersects the centreline of bridge at a point about 1631 feet south of the end of the continuous tied arch or centreline of pier no. 14.

A movable span arrangement in way of the canal being definitely undesirable with heavy roadway traffic, a new high level south approach was decided upon. This decision required that the existing concrete approach be completely demolished and removed. Before its destruction,

Fig. 5. Sketch of completed Jacques Cartier Bridge project and new approach.

traffic will be diverted off the upstream side of the continuous span near pier no. 14 to a temporary turn-off fill.

The new approach will remain on the centreline of the existing bridge, from pier no. 14 to pier no. 29. From pier no. 14 to pier no. 15, there will be a simple 55 foot deck truss span. From pier 15 to pier no. 27, a length of 1424 feet, there will be twelve continuous deck truss spans. From pier no. 27 to pier no. 28, there will be a 300 foot through camel-back truss span over the canal, and from pier no. 28 to pier no. 29, a simple 100 foot deck truss span.

These spans will provide two 26 foot roadways with a 6 foot median strip between, a 4 ft. 4 in. sidewalk on the upstream side and a 2 ft. 10 in. safety-way on the downstream side.

The deck spans will have four longitudinal trusses supporting transverse floor beams at 12 ft. 3 in. centres, which, in turn, will support longitudinal centres at 5 ft. 3 in. centres.

To maintain a minimum depth from floor level to the 120 foot clearance line over the canal high water level, the through span will have three supporting trusses, one truss being in the centre of the median strip. The floor elevation at pier no. 27 and pier no. 28, governed by the floor and chord proportioning of the through span, is about 163.5 feet above the canal bottom. From pier no. 27 to pier no. 14, a maximum downgrade of 4.25 per cent is permitted. This means that at pier no. 14, the new approach level is 6.3 feet above that of the existing continuous tied arch span. An involved operation will consequently be required to amend the floor of the existing span and, at the same time, maintain traffic.

South of pier no. 29, all spans will be of the riveted deck plate girder type and there will be three distinct approaches. An east approach for both east and northbound traffic; a west approach for westbound traffic only and a west approach for northbound traffic only.

The east approach from pier no. 29 to the east abutment is on a 790 foot radius curve, 1407 feet long, and contains fifteen spans. It provides for dual 26 foot roadways with 6 ft. median strip between and is on a 4.25 per cent grade.

The west westbound approach is

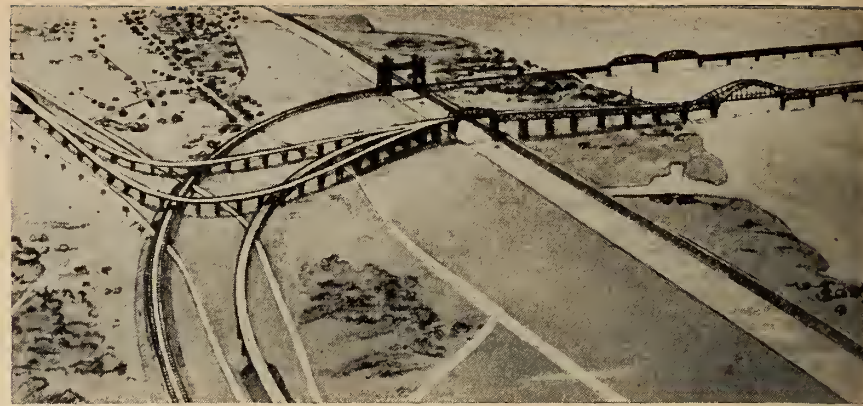


Fig. 6. Revised Honore Mercier Bridge south approach and new Caughnawaga railway vertical lift span.

1733 feet long from pier no. 29 to the west abutment and comprises sixteen spans. It provides for a single 26 foot roadway and its 2.75 per cent grade clears the Canadian Pacific Railways embankment. The west northbound approach is on a sweeping curve, east of the westbound approach and is 1953 feet long from the west abutment to pier no. 29. It passes over both the Canadian Pacific Railway embankment and the east approach. It contains 22 spans and also provides for a single 26 ft. roadway.

The two spans between piers no. 14 and no. 16, will be erected by crawler crane from the ground. A 12-ton stiff leg derrick mounted on a truck-equipped platform, placed on the span from pier no. 15 to pier no. 16 will erect the spans from pier no. 16 to pier no. 27, by cantilevering from pier to pier. The simple deck truss span between pier no. 28 and pier 29, will also be erected by crawler crane and on it, will be assembled an 18-ton top chord traveller to erect the through span. The traveller will proceed from pier no. 28 to pier no. 27, erecting floor steel and truss members panel by panel on 160 ft. high timber falsework from the canal bottom.

The east approach spans will be erected with a 35-ton traveller, starting at the east abutment and proceeding towards pier no. 29. There, it will be turned around and erect the spans of the west northbound approach from pier no. 29 to the west abutment. There, the traveller will be turned again and proceed to erect the spans of the west westbound approach from the west abutment to pier no. 29.

The St. Lawrence Seaway Authority's construction schedule requires that the spans, from pier no. 14 to the east abutment, as well as the alteration to the anchor arm of the continuous tied arch be completed during the summer of 1958 and that the remaining two west approaches be completed early in 1959. This means that temporarily, both east and westbound traffic will be using the east approach. The purpose of this requirement is to expedite the removal of the turnoff fill in way of the canal.

CAUGHNAWAGA RAILWAY BRIDGE

Approximately four hundred yards from and nearly parallel to the Honoré Mercier bridge is the double-track Caughnawaga bridge, owned and operated by the Canadian Pacific Railway. Actually, the bridge is two separate bridges, side by side, one for each track. At the south end of the bridge, the right of way leads on to a 60 ft. high embankment which curves eastward on approximately a 3000 ft. radius. The Seaway canal does not affect the bridge proper but cuts through this embankment about 1300 ft. south of the end span.

Railway grade restrictions necessarily dictated a movable span as solution to provide the canal clearance of 120 feet.

To permit construction of this new bridge and not interfere with present railway operations, a revised position on the railway tracks was decided upon. This new position will be on a chord of the curved section of the present south embankment. This chord will be of sufficient length to provide adequate transverse construction clearance. Again, there will be an individual bridge for each track. As the angle between the canal bridge centrelines is 59 deg., the bridge for the southbound track will be about 16 ft. north of that for the northbound track. Transversely, the bridges will be at 27 ft. centres. Each track bridge will consist of a 322 ft. lift span flanked at each end by 66 ft. tower spans which, in turn, will be flanked by 55 ft. approach deck girder spans.

Each lift span has 12 panel camelback trusses at 19 ft. centres with a centre depth of 45 ft. between deck girder spans connect the backleg piers to retaining walls introduced to independently resist the longitudinal pressure of the new fill required to join up with the existing railway embankment.

The same two 20-ton guy derricks and 90 ft. steel towers referred to in the erection of the Victoria bridge upper lift span will be used to erect the tower spans and counterweight sheaves. One derrick will be placed over each backleg pier.

A 50-ton capacity locomotive crane will erect the south approach span and then proceed to erect the lift roughly opposite the centreline of the southbound tracks. Consequently, only falsework in way of the northbound track can be erected. The lift span of the southbound track will be erected first and then translated to its permanent position, using roller trucks and hydraulic jacks. The northbound lift span will then be erected on the same falsework and upon completion, the falsework will be removed.

NOTE

The engineering department of the St. Lawrence Seaway has delegated its authority to Dr. P. L. Pratley,

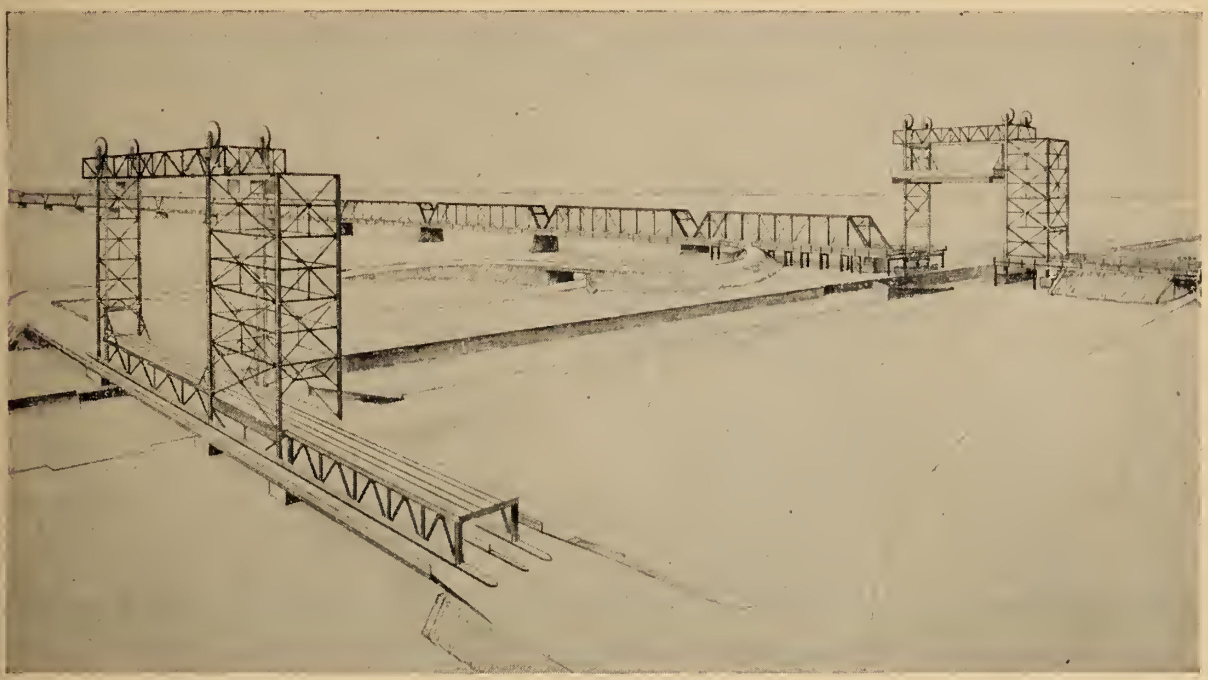


Fig. 7. Artist's sketch of the St. Lambert Lock area at the south end of Victoria Bridge.

chords. The operating machinery house is located at mid-span between the railroad clearance line and the top chord. The tower spans combine at the same time longitudinal bracing of the counterweight sheave posts and a 66 ft. track span between the main pier and backleg pier. The centreline of counterweight sheaves is 133 ft. about the base of rail. The span by first placing the floor steel and bottom chords on 80 ft. falsework bents from the canal bottom. It will then back up and erect the remaining truss members and overhead bracing.

Due to the proximity of the toe of the existing railway embankment, it is not possible to excavate to the bottom of the canal, west of a line M.E.I.C., consulting engineer, for the Jacques Cartier bridge Project, and to Messrs. Lalonde & Valois, consulting engineers, for the Honoré Mercier bridge south approach revisions.

Joint approval by the St. Lawrence Seaway Authority and the railway company concerned, is required for the Victoria and Caughnawaga bridge projects.

Progress Report on the St. Lawrence Power-house Project

O. Holden, M.E.I.C., *Chief Engineer*

P. Pemberton-Piggot, *Assistant Mechanical Engineer*

The Hydro-Electric Power Commission of Ontario

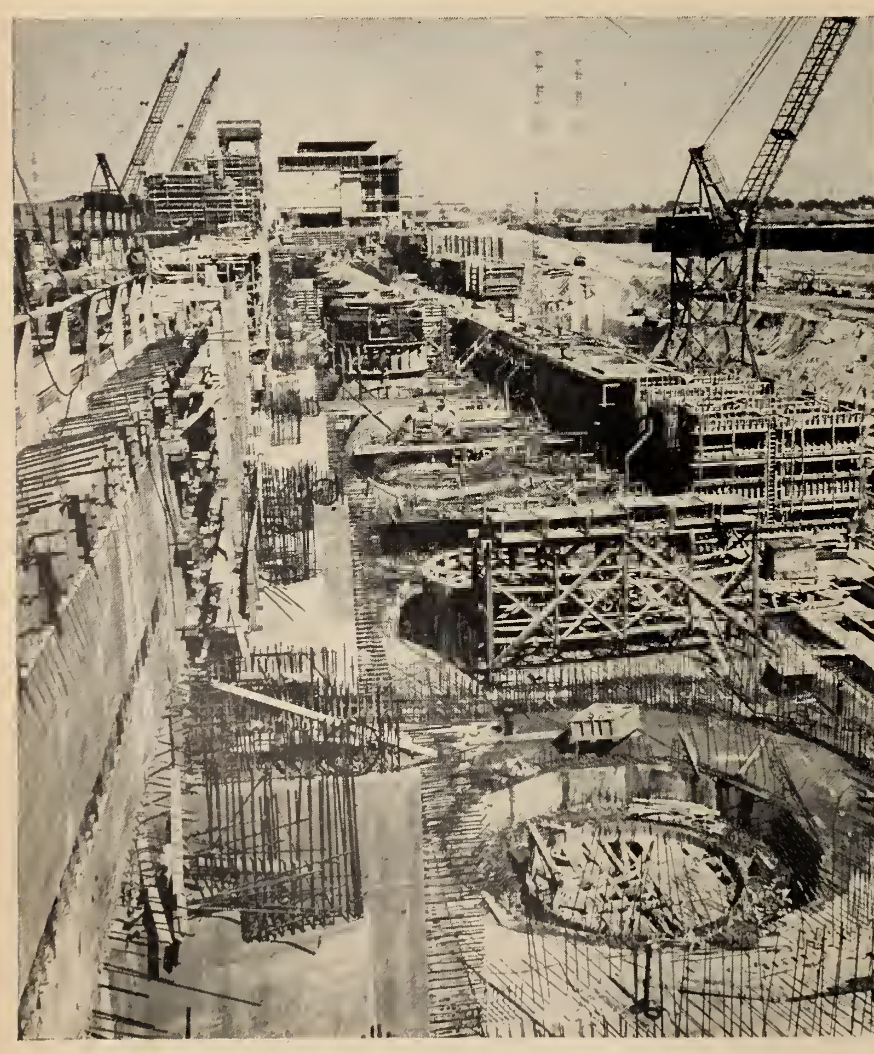
THE ST. LAWRENCE Power Project, now being constructed jointly by Ontario Hydro and The Power Authority of the State of New York, requires a wide range of mechanical equipment. Some items have already been installed and placed in service to assist in the construction work taking place along the International Rapids section of the St. Lawrence River.

There are three main structures in which the bulk of this equipment is being installed. These are:

(1) The adjoining powerhouses, one Canadian and one American, which form a dam between the Ontario shore and Barnhart Island.

(2) Long Sault dam located between Barnhart Island and the American shore which is the main spillway structure. It is from here that the river levels upstream to the Village of Iroquois will be controlled.

Figure 1.



(3) The Iroquois control dam which spans the river between Iroquois and Point Rockway. This dam controls the outflow from Lake Ontario.

The powerhouses are of the semi-outdoor type with no superstructure over the units. An enclosed erection bay and administration area is provided at each end of the structure. Each powerhouse will contain sixteen 75,000 horsepower fixed-blade propeller turbines directly connected to 60,000-kva. vertical generators. The powerhouses also contain six ice sluices which are located in pairs at the International Boundary and each shore. The overall length of the structure, comprising both powerhouses and erection bays is 3,120 feet.

Crane service is provided for the erection and maintenance of the generating units; two 300-ton enclosed gantry cranes—one in each powerhouse. Additional crane service is provided in each erection bay by overhead travelling cranes while the headworks are serviced by two 90-ton gantry cranes. The extensive auxiliary equipment required for the plant is located in the lower level of the erection bays and in other convenient areas throughout the length of the plant.

Long Sault dam will be equipped with thirty spillway gates each 50 feet wide by 30 feet high. Eighteen of these gates are provided with individual hoists while two 275-ton gantry cranes provide the means of operation for the remaining gates and also maintenance service for the dam. At the present time, the first stage of Long Sault is controlling the entire flow of the St. Lawrence River through thirteen temporary diversion sluices. The flow through these diversion sluices is controlled by gates made up from sections of the final spillway gates. The second stage of the dam, now under construction, will be provided with diversion ports

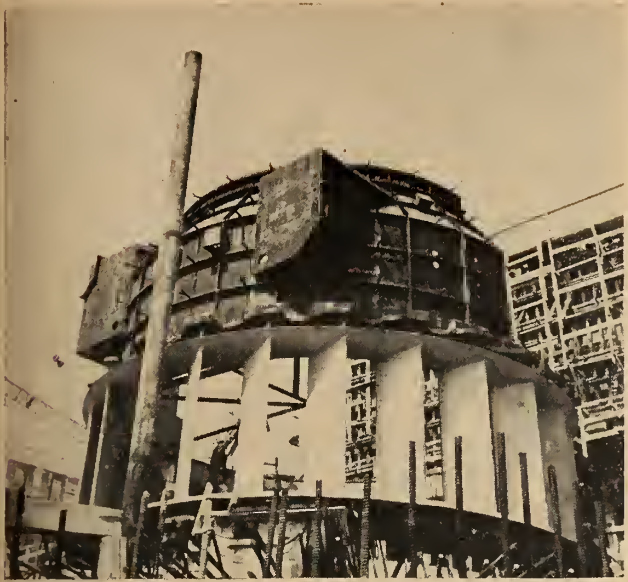


Figure 4.

which will be used for the final closure procedure.

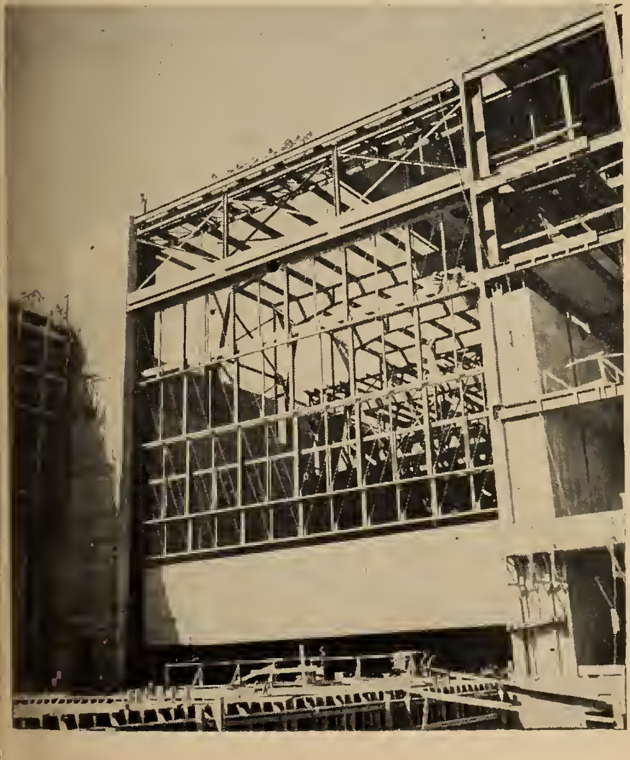
Iroquois dam will consist of thirty-two sluices each provided with a 50-foot wide by 48-foot high single-section sluice gate. The gates are handled by two 320-ton gantry cranes which are now in service controlling the river flow through the first stage of the dam.

It will be seen from the accompanying photographs that construction progress is already well advanced. The project is scheduled to go into service in the summer of 1958.

Figure 1

This photograph shows the gen-

Left (above), Fig. 2.; (below) Fig. 3.



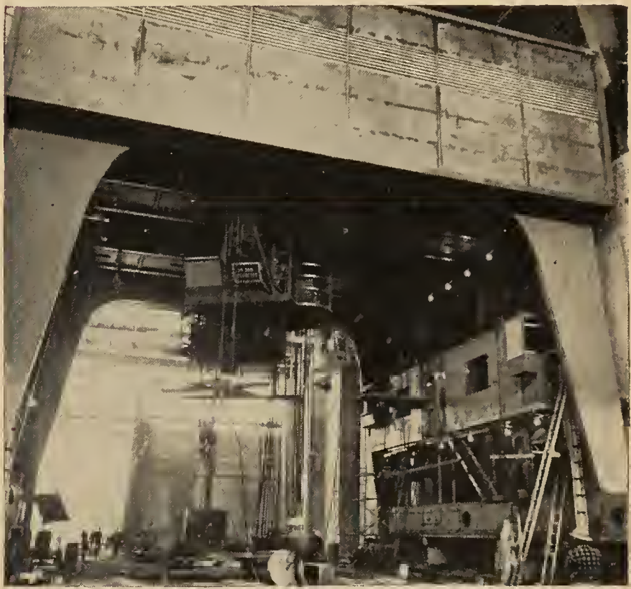
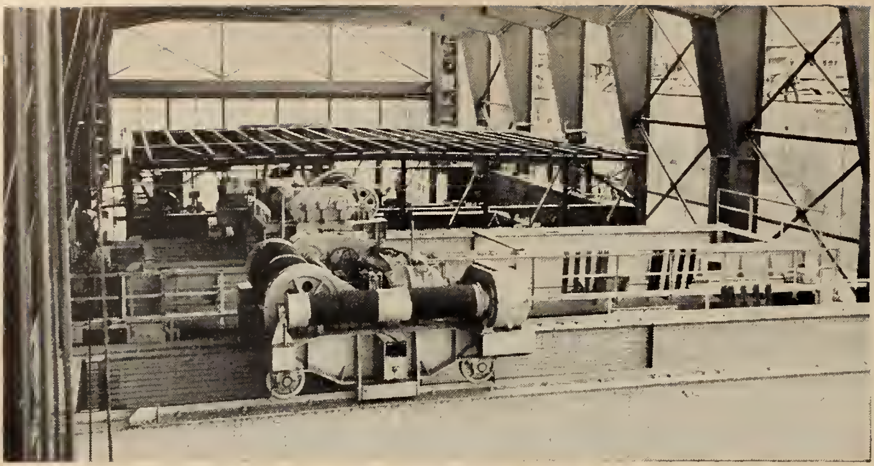
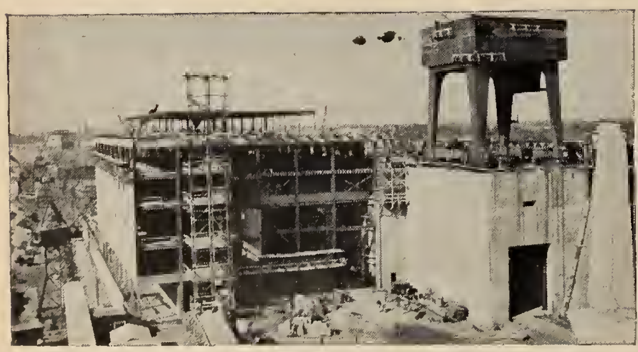
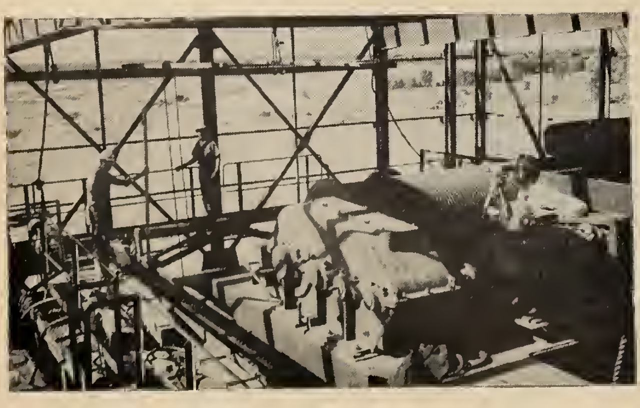


Fig. 5 (above); Fig. 6 (below).







Top to bottom, Figs. 7, 8, 9 and 10; below (right), Fig. 11.

eral view of the Canadian powerhouse. The embedded parts of unit 12 are clearly visible in the centre of the picture. In the background may be seen the erection bay and the headworks gantry. The large door in the face of the erection bay permits the 300-ton powerhouse gantry to pass into the building.

Figure 2

This picture shows a close-up view of the embedded parts of one of the 75,000-horsepower turbines. The size of the speed ring may be gauged by the man standing inside the ring.

Figure 3

This picture shows the completed framing of the big gantry entrance door in the erection bay. The door is 60 ft. 6¾ in. wide and the five vertical lifting blades are arranged to give a clear opening height of 58 ft. 6 in. The roof framing of the erection bay and of the 300-ton gantry may be seen through the latticework of the door.

Figure 4

This picture is taken inside the Canadian erection bay and the gantry entrance door may be seen in the background. The upper panels of the door have received their aluminum facings while insulation batts may be seen on the lower panels. The large gantry crane is the 300-ton capacity crane used for servicing the units. In the foreground is the runner hub and blades of one of the turbines. On the right hand side will be seen bundles of reinforcing steel which were used for the load test on the 80-ton capacity overhead cranes, one of which may be seen at the top of the picture.

Figure 5

This picture shows the erection of the 300-ton gantry crane nearing completion. In the centre of the picture will be seen the 15-ton capacity jib cranes which provide auxiliary hook service within the gantry crane enclosure. The crane is equipped with rolling doors at each end, one of the guides for which may be seen at the right hand leg of the crane. The gallery on the right hand side of the crane encloses the crane cabs and the various motor control centers.

Figure 6

This picture shows the downstream side of the 300-ton gantry crane. The arrangement of the control gallery and various access stairways may be seen. In the lower left is one of the travel drive units and on the right hand side may be seen the 300-ton hook block. At the top of the picture is the underside of one of the jib cranes showing the arrangement of the collector post.

Figure 7

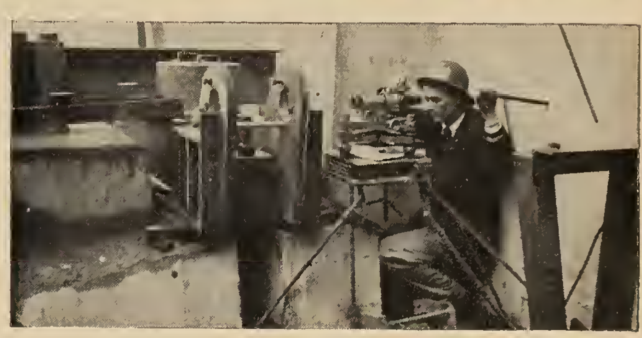
This picture shows the two 80-ton overhead cranes in the Canadian erection bay. The hoisting drums had not been reeved when this picture was taken although the cranes are now in service asssembling turbine and generator parts. It will be noted that the long auxiliary hook drum is placed at right angles to the main hoist drum and positions the auxiliary hook outside the crane girder. This arrangement not only makes for a very compact trolley but also permits a very close hook approach to the walls of the erection bay. In the background may be seen the roof framing of the 300-ton gantry crane and the counterweight guide tower of the gantry crane entrance door.

Figure 8

This picture shows the detail of the arrangement of one of the 80-ton erection bay crane trolleys. The

Figure 12.

Figure 13.



Below, Fig. 14.

mechanical load brakes of the two hoist drives are enclosed within the gear boxes while thrustor-operated holding brakes are located on the extended motor shaft. The trolley travel drive unit is provided with forced lubrication, the piping for which may be seen on the gear case at the right front of the picture. This picture again emphasizes the compactness of the trolley and clearly shows how the auxiliary hook may be placed within 18 inches of the end wall of the building.

Figure 9. (p. 1458)

This picture shows the Canadian end of the powerhouse structure. The overhead cranes may be discerned in the erection bay while the dominating feature is the headworks gantry which is in the process of being erected. The door under the gantry leads to a headgate maintenance area and also provides a route for equipment on its way to the headworks deck. This picture does not show that the 90-ton headworks gantry is also equipped with a 15-ton capacity jib. This is located on the far leg and is used in handling stoplogs, trash racks, etc.

Figure 10

This picture shows the trolley of the 90-ton headworks gantry crane during erection. The men in the picture are engaged in checking the trolley rails for level. In the foreground may be seen the Cornwall dyke and the canal closure structure through which the 14-foot Canadian navigation canal is now being diverted.

Figure 11

This picture shows one of the Canadian headgates being unloaded off a boat in the 14-foot Cornwall canal. The gates are unloaded by a derrick specially erected at the site for this purpose. It will be noted that the gates are shipped complete in one piece in spite of the fact that they weigh over 40 tons each.

Figure 12

This picture shows the hinges of one of the ice sluice drum gates, six of which are being installed in the powerhouses. At the extreme top right of the picture may be seen the rail for the headworks gantry which is carried over the sluice by the heavy steel girder dominating the upper part of the picture. In the extreme lower left hand corner may be seen two of the dogging posts which will be used to support the gates during maintenance. The heavy scaffolding in the flotation chamber will be used to support the gate bottom during its erection.

Figure 13

This picture shows the setup used to check the alignment of the ice sluice drum gate hinges prior to concreting.

Figure 14

This picture is an aerial view of Long Sault dam showing the entire St. Lawrence river flow of approximately 240,000 cfs. passing through the diversion sluices in the first stage of the dam. In the centre may be seen the second stage of the dam under construction. On the left hand side of this portion of the dam may be seen the discharge opening of the diversion ports which will be used during the final closure procedure. On the top of the completed portion of the dam may be seen the two 275-ton gantry cranes which are now

Above, Fig. 15.

Left, Fig. 16.

Above, Fig. 17; below, Fig. 18.

being used to handle the sluice gates in the diversion control position.

Figure 15

This is a downstream view of the first stage of Long Sault dam at the commencement of diversion. It will be noted that the crane is provided with a double drum main hoist and handles the gates through a lifting beam.

Figure 16

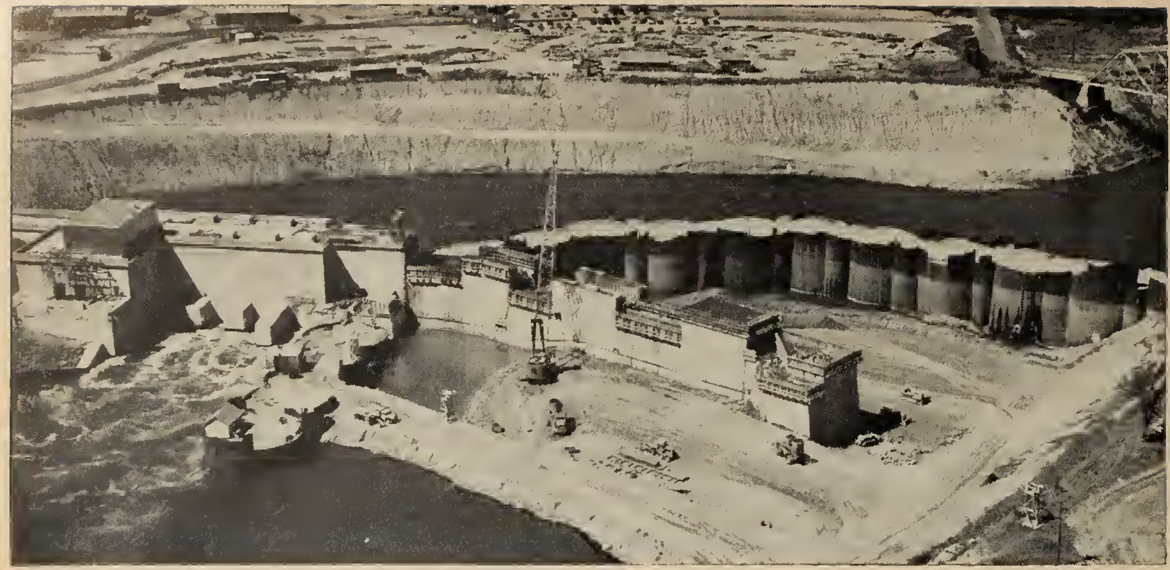
This picture is an upstream view of Long Sault dam showing the diversion control gates and their temporary guides. It will be seen that the gates are made up of a number of sections to give the required height. They will later be re-assembled to provide the 30-foot high spillway gates required for the completed dam.

Figure 17

This is an aerial view of the Iroquois dam area. The dam itself can be seen with the river flow passing through the first stage sluices. The second stage of the dam can be seen behind the steel cell cofferdam and this section is now complete. In the immediate foreground may be seen work in progress on the entrance to the new Canadian Seaway Iroquois lock. To its right may be seen part of the excavation of Iroquois Point. It will be noted that the outstanding feature of the dam is the pair of 350-ton capacity gantry cranes used to handle the sluice gates.

Figure 18

This picture shows the 50-foot by 48-foot high gates of Iroquois Dam with the full river flow passing through the sluices of the first stage. When in the full raised position the upper portions of the gates are braced by concrete towers, which may be discerned between the gates on the left and are visible under the left hand gantry crane.

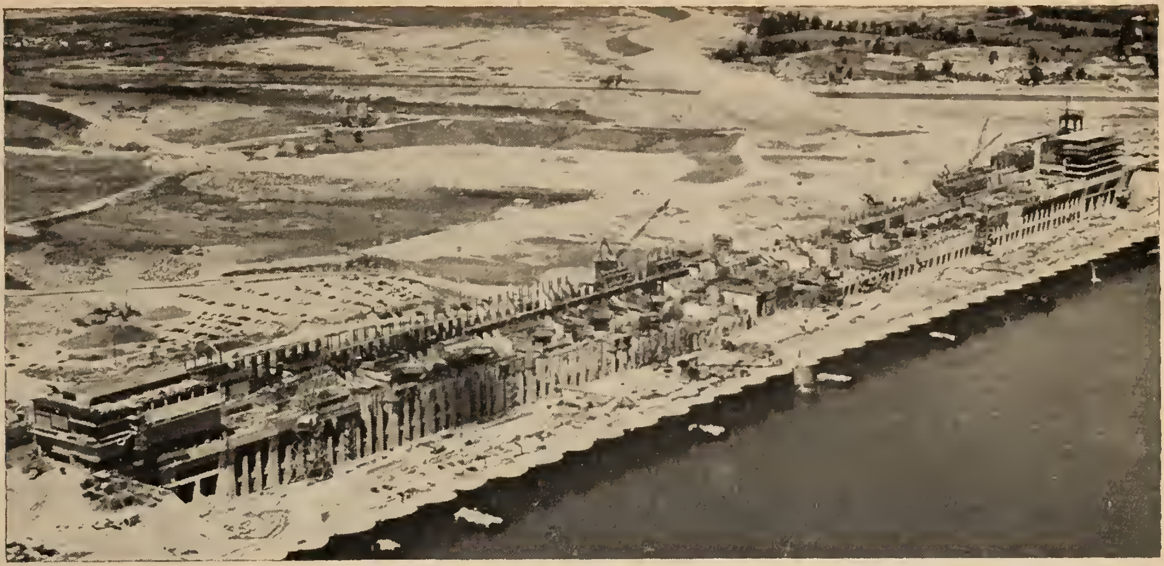


Progress of the seaway produced these typical scenes during 1957

Massena intake (top), as blocks of concrete approached the final grade in August.

Iroquois dam (centre), as 81,000-lb. steel beam was being lowered into forms to be encased in concrete, July.

St. Lambert lock (bottom). At this place lift spans will be installed to allow passage of ships. View from floor of the lock shows Victoria bridge.



St. Lawrence power dam (above)—general view of the structure as it was in August.

Channel improvements (left). Excavation at Point-Three-Points in the foreground was nearing completion in June, and rim dike was being removed.

Iroquois dam (right). Looking upstream at the dam in the foreground, Iroquois lock on Iroquois Point; Toussaints Island and Sparrowhawk Point in the distance; showing progress in June.

Shear, Diagonal Tension, and Bond Stresses in Reinforced Concrete Beams

E. M. Rensaa, M.E.I.C.

Consulting Engineer, Rensaa & Minoss, Edmonton, Alberta

IN A PREVIOUS ARTICLE, "Will Ultimate Strength Design of Reinforced Concrete Beams Simplify Stress Calculation", *(Eng. Jnl.* 1957, June, 805) the author discussed some aspects of bending stresses. This article will deal with certain problems relative to diagonal tension, and bonding of reinforcing steel. The object of these articles is an attempt to contribute to a better understanding of the action of internal forces. The value of such an understanding of fundamental facts can hardly be overestimated. A designer of reinforced concrete structures often encounters problems whose safe and economical solutions cannot be found from examples in textbooks. Deficiency in fundamental understanding may either lead to uneconomical design or to structural failure. There have been several such failures of important structures in North America during the last few years. This is sufficient proof that our knowledge of the fundamental facts is still incomplete.

The present article deals with problems which have come to the forefront recently due to several failures of reinforced concrete building frames in North America. It is especially shear conditions at points of contraflexure which have caused trouble. The author has explained the stress conditions at these points and has shown that our present code provisions are insufficient in many instances to prevent shear failures.

Shear

Concrete has a relatively high shearing strength and true shear very seldom is an initial cause of failure. It is difficult to determine real shearing strength accurately and test results show great variation depending on how successful the investigator has been in reducing accompanying tensile stresses which are nearly impossible to eliminate completely.

The true shear strength can only be obtained when the test specimen is prevented from expansion both perpendicular to the plane of shear and parallel to this plane in a transverse direction. However, such a condition of restraint will seldom if ever be obtainable in practice and that applies particularly to transverse restraint.

Shear tests of rectangular and other concrete specimens have been carried out by Dr. E. Mörsch,[1] and by Bach in Germany, and by Professor E. Suenson[2] in Denmark. The results of these tests indicate a shearing strength of about 3 to 3.6 times the tensile strength of concrete. Assuming the tensile strength of concrete to be one - tenth the compressive strength, we may suppose that the shearing strength under such conditions as prevailed in the tests is about 30 to 36 per cent of the compressive concrete strength.

Other investigators have found much higher percentages of shearing strength. Feret found an average of about 50 per cent, Professor C. M. Spofford obtained from 63 to 104 per cent, and tests at the University of Illinois indicated a percentage of from 44 to 57 of the compressive strength.[3]

It is likely that direct compression or tension perpendicular to the plane of shear will have a great influence on the nominal shear strength.

It would appear that the lower percentages of shearing strength found by Mörsch, Bach, and Suenson are most in line with what might be expected in practice where transverse and longitudinal restraints are either incomplete or lacking. However, since the shearing strength in any case is fairly high, it is only in exceptional cases such as where a heavy concentrated load is acting close to a support that there is any appreciable danger of initial failure by shear. Another, and more usual case, is where a crack caused by diagonal tension has extended so far towards the compression side of the beam that the remaining uncracked concrete has insufficient shearing resistance.

Diagonal Tension

Even though shearing stress alone seldom is a primary cause of failure, the shear combined with bending moment tension may form a resultant diagonal tensile stress which frequently causes initial cracking. This principal stress unless adequately reinforced against very often limits the carrying capacity of a beam. Although shear is thus only a component of the principal stress, it is generally used as a measure of ability of a beam to resist principal tensile stresses. The shear component is only usable for that purpose where the member is not subject to axial tension or compression which will modify the resultant principal stresses. This fact is unfortunately often disregarded and in the case of members subject to axial tension, such an omission may lead to unsafe designs. The adoption of the transverse shear force alone and its corresponding shearing stresses as a basis for the design of web reinforcing has caused a great deal of misunderstanding of the actual condition of internal stresses in reinforced concrete members. It would undoubtedly have been better if, from the beginning, principal stresses had been made the basis for calculation and design of web reinforcing.

Concrete has a comparatively low tensile strength and failure caused by tension in an unreinforced, or lightly reinforced section, will generally be quite sudden without much previous warning. This also applies to failure caused by diagonal tension. In the design of reinforced concrete beams, it is usual to assume that concrete has no tensile strength. When it comes to diagonal tension, the practice is not so uniform. European custom is, in the case of rectangular beams and T-beams, either to reinforce for the complete shear or diagonal tension regardless of unit stresses or to reinforce for the complete shear only where the stress exceeds a certain value. The Canadian reinforced concrete code of 1941 assumed the concrete to take some shear up to a certain limiting stress. For unit stresses above this limit, the complete shear was to be taken by reinforcing. This provision was, unfortunately, not retained in our code of 1953. Our present specifications, which are based on the American Concrete Institute Code of 1951, assume that concrete can carry a certain part of the shear regardless of the magnitude of the shearing stress. That was also the assumption in Europe until abandoned about 30 to 40 years ago. In the U.S.A. this assumption has been upheld tenaciously because tests show that in the case of combined bending and shear the compression zone can actually carry some shear even after the tension zone has cracked. The assumption has the economic advantage that less web reinforcing is required so that most often it is found possible to use stirrups alone where reinforcing for the complete shear would have required the use of a larger size bent-up bars. The use of such bars may require some extra work, so in spite of a much better efficiency they are not generally favoured in North America.

Another misconception is the assumption that the tensile strength of concrete increases in direct proportion to an increase of its compressive strength. Actually the tensile strength increases more slowly. Since we use shear as a measure of diagonal tension, it is incorrect to assume the diagonal tensile strength to increase in proportion to the compressive strength even if the sheering strength increases in such proportion. When concrete is assumed to carry part of the shear, the result of this misconception is often a lowering of the safety factor for diagonal tension when a high strength concrete is used.

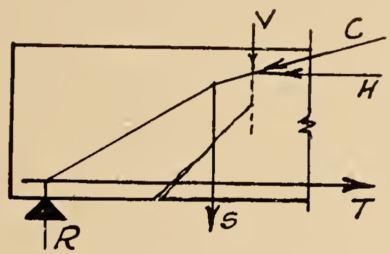


Fig. 1.

A deficient understanding of the necessary conditions for enabling concrete to participate in the carrying of part of the shear has caused unsafe designs to be brought out. Several failures in the U.S.A. caused by insufficient web reinforcing has brought about some strengthening of requirements for such reinforcing in the last revision of the American Concrete Institute code of 1956. There are certain cases, however, such as at points of contraflexure in continuous beams subject also to longitudinal tensile forces, where reinforcing for the complete shear becomes necessary even for comparatively low shearing stresses.

It is undoubtedly true that concrete can carry some shearing stress where it is uncracked. That will be the case for the compression zone of a beam subject to bending. In this uncracked part of the beam, the critical stress, apart from direct compression, will generally be shear and not diagonal tension. The diagonal component from shear is here counteracted by a component from compression and the directions of principal stresses are different from those in the portion of beam below the neutral axis.

Consider the left portion of a beam, Fig. 1, where a crack has formed up to the compression zone. It is clear, that in order to retain equilibrium, the resultant of the horizontal compression and of the shear at the section must intersect the line of action of the resultant of external reaction and loads and the line of action of the reinforcing at the same point. If there is no web reinforcing crossing the crack the whole shear must be taken by the concrete which is in compression, if we disregard the small portion which might be carried by the horizontal steel acting as dowels. It is not likely that interlocking of aggregate across the crack will carry any appreciable portion of the shear. The contention that concrete can carry some shear is, therefore, true for a case where some portion is uncracked. However, it is also clear that as the crack moves upward, the section of concrete which must carry the shear becomes smaller and the unit stress correspondingly higher. We may then get a failure caused by combined shear and direct compression. The function of a well designed web reinforcing should be to hinder a diagonal tension crack from moving so far upwards that the remaining uncracked portion becomes too weak to resist the combined action of shear and compression. Numerous tests have shown that for such cases where shear has any influence on ultimate strength, the carrying capacity will increase with an increase of properly designed web reinforcing. This applies at least until sufficient web reinforcing is provided to carry the complete shear.[4]

Transverse forces and the reaction from a support have some local modifying influence on the principal stresses. Investigators have found that compression from a support increased the principal compressive stress by 38 per cent and decreased the principal tensile stress by 28 per cent.[5] The important part of this stress change is, of course, the beneficial decrease of diagonal tension. Since this decrease only occurs near the support, it is obvious that a shearing stress of the same magnitude is more dangerous farther out on the beam than near a support.

What Type of Web Reinforcing is Most Advantageous

There has been, in the author's opinion, rather too much importance attributed to the question of how big a proportion, if any, of the shear can be assumed to be carried by the concrete. A much more important consideration is that in general, it is undesirable that failure of a beam under maximum loading should be due to shear, diagonal tension or bond. Such failures in practice are often sudden without much previous warning and may therefore be very dangerous. If we decide, as the author thinks we should, that failures of this kind should be avoided, it becomes necessary to determine how much reinforcing is necessary for that purpose. For a non-homogeneous variable material like reinforced concrete, theoretical considerations are not sufficient, and testing becomes the most reliable method

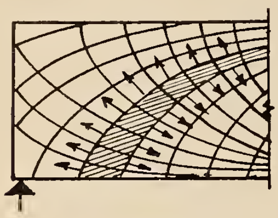


Fig. 2

of solution. A large number of tests have been carried out, particularly in Europe, for the purpose of finding what kind and amount of web reinforcing is best suited for prevention of diagonal tension or shear failures. In general it may be said that a combination of bent-up bars and stirrups is the most efficient arrangement. Bars bent up at approximately 45 degrees angles will most nearly conform with principal tensile stresses near the supports and will get into action earlier than stirrups.[4] Stirrups on the other hand will perform the very useful additional function of reinforcing a beam transversely against additional function of reinforcing a beam transversely against splitting forces caused by tension in the main horizontal reinforcing. It must be recognized, however, that apart from resisting splitting, stirrups can only carry the vertical component of the principal tensile stresses. The horizontal component must be carried by horizontal reinforcing. For a certain crack pattern, this condition may increase the tension in the horizontal reinforcing considerably above what is found from ordinary bending moment calculations. The reasons for this will be explained later.

European practice is generally based on the assumption that shear and diagonal tension should not form the limit for the ultimate strength of a beam. If we adopt this evidently sound principle, it will in many cases necessitate the use of more web reinforcing than what is presently prescribed by our codes. Any design should provide a certain safety factor so that a structure subject to ordinary loading is not on the verge of failure. We have experienced that in the case of web reinforcing such a safety factor is not always present because even structures subjected to dead load alone have fallen down due to lack of shear resistance.

It is desirable that web reinforcing should be placed in such a manner as to be utilized to its greatest possible efficiency. North American specifications state that only three-quarters of the horizontal projection of bent-up bars shall be considered effective as shear reinforcement. The question may then be asked if such a restriction is justified. In order to answer this question it will be useful to consider the stress trajectories of a homogeneous beam, Fig. 2.

Before the formation of cracks, it is reasonable to assume that stresses will form a pattern about the same as in a beam of homogeneous material. The presence of reinforcing steel will of course cause some modification, but probably not to any great

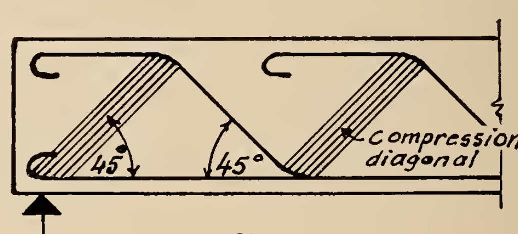


Fig. 3

extent. The first crack will run approximately perpendicular to lines of principal tensile stresses, but of course, somewhat irregular due to local strength variations. The shaded portion between two stress trajectories may be considered as a compression member and the stresses perpendicular thereto must be tensile in order to maintain equilibrium. Since in a reinforced concrete beam we cannot depend on the tensile strength of concrete, we must provide reinforcing to carry the tensile stresses. From these considerations we may assume the combination of concrete compression members and steel tension members to form a structure analogical to a truss. (Originally introduced by Dr. Mörsch). The compression and tension diagonals, indicated in Fig. 3, will form a truss of the Warren type with slope of diagonals at about 45 degrees, corresponding to the direction of principal stresses at the neutral axis. Tests of beams with reinforcing bent up according to this pattern show considerable effectiveness; but does not provide complete protection against formation of diagonal tension cracks. If bent-up bars are spaced farther apart, there will be a certain intermediate portion which would not get sufficient help from them. Both European and American tests have shown that cracks may develop if the horizontal distance between bent-up bars exceeds 1.25 to 1.5 times the effective depth.[6] In the continental countries of Europe it is, therefore, considered safe to limit the length between bent-up bars to a distance equal to the effective depth. British custom seems to allow a somewhat bigger spacing corresponding to Fig. 4. It would, in any case, be safe enough to consider the horizontal projection of a bar bent up at 45 degrees as being effective. Specifying an effective limit of three-quarters of the projection may be justified near a support for bars bent up at 30 degrees or less with the horizontal, but certainly not for the more usual bending up at 45 degrees. The short distance on which bent-up bars are speci-

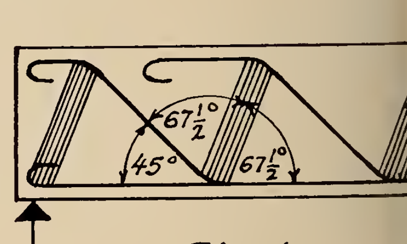


Fig. 4

fied to be effective greatly reduces their economic usefulness. This is, undoubtedly, one reason why bent-up bars are not used as shear reinforcing to the same extent in North America as in Europe. Even if it is found here that the use of stirrups is cheaper that is not a good reason for discriminating against bent-up bars in a manner contrary to facts.

Shear at Points of Contraflexure

In the case of simply supported beams there may be a basis for th assumption that concrete will tak some part of the shear and the web reinforcing the rest. How the actual distribution will be between such differently arranged structural parts is not easy to determine. Where material of different kinds is used to form a structure, it is always a possibility that one kind may fail before the other gets into action. Steel will stand overstressing to a considerable extent and may generally be depended on to act together with concrete as long as the concrete acts. If, on the other hand, the concrete should fail first and the steel then get into action, the whole load would, in such a case, have to be carried by the steel.

The above considerations make it plain that concrete can only be depended on to carry stresses as long as it has not cracked. If a crack has formed that part is no longer able to take either tension or shear, and it is only the uncracked part which is available for carrying stresses. It has been stated that in a beam, subject to bending in addition to shear, the concrete in compression will generally also be able to carry some shear because this part is uncracked. If, however, there is no bending, a crack formed either by the diagonal component of vertical shear alone or by a combination of shear and direct tension, will likely cause this crack to extend completely through the section. The whole shear and direct tension will then have to be carried by the steel without any help from the concrete. If the steel is not strong enough for that purpose, the result will be complete failure. Such a condition is encountered at a point of contraflexure of a continuous beam where there is no bending but only transverse shear. There may be in addition either direct tension or compression acting in the longitudinal direction of the beam. If the direct load is compression, the diagonal tension component will be smaller, but if there is longitudinal tension, the combined diagonal tension component will be greater with a correspondingly decreased factor of safety.

The assumption of interaction of concrete and web reinforcing is evidently quite erroneous for conditions where there is no bending such as at points of contraflexure in a continuous beam. There is little reason why there should only be a crack through part of the concrete at such points. We shall have to expect either no crack or a crack cutting completely through the member. Where there is no crack, the concrete will take practically the complete shear and, if a crack goes through the member completely, all the shear will have to be taken by the reinforcing steel. The web steel will take most of the shear and will only get some small help from the horizontal steel acting as dowels. Any appreciable help from interlocking of concrete aggregates across a crack is hardly to be expected.[7]

There has been an exaggerated belief in the importance of dowel action to carry some part of the shear. To quote from an American textbook on reinforced concrete, "If there is steel passing through the section, the resistance to vertical shear is much increased, since the steel must also be sliced off to produce failure. Therefore, a maximum shear intensity of 0.06 f'_c is allowed for ordinary anchorage. If there is steel at both top and bottom, there is still greater resistance to shear, and even higher allowable values may be used for the combined action of steel and concrete."

It would indeed be nice if both concrete and horizontal bars would act in combination until the steel was "sliced off". The actual condition, unfortunately, is not so favourable. What happens is that the transverse pressure from the longitudinal steel will split the concrete, so that the bars are pulled away from the main body of beam without being sliced off. Splitting will start at the main crack and transfer the vertical shear to the nearest stirrup. One stirrup alone, or even one on each side of the main crack at top and bottom, may not be sufficient to carry the shear. The result will likely be progressive tearing off of stirrups as split or splits develop. This condition is illustrated in the report of failure of roof beams of U.S.A. Army warehouses.[8]

The ordinary formula for shear in a reinforced concrete beam $v=V/b.jd$ is based on the assumption that the concrete below the neutral axis is unable to take tension but may take shear. This assumption is evidently quite erroneous. No shear can, of course, be transmitted across an open crack and it is unlikely that any considerable shear can be transmitted parallel to the crack by interlocking of concrete aggregates. The part of shear not carried by the web reinforcing must therefore be carried by whatever part of the concrete section, if any, remains uncracked. The shear diagram would then be quite different from that obtained by the usual formula. That this formula does not give true values but only relative ones has been known for many years.[9] The formula has, however, been used for such a long time that many engineers believe that it was intended to give exact figures.

In spite of the fact that only relative shear values are obtained by the formula, it still is useful as a standard of comparison. This usefulness, however, is limited to conditions which in practice would give the same factors of safety for all similar relative shear values. The allowable shear is based on tests of beams simply supported where all sections are subject to bending and shear. If the compressive bending stress is non existent or springs from one side of the beam to the other at a section, we should not expect to obtain the same test result as for a simple beam. Under such circumstances the relative figures obtained by the usual shear formula loses its value as a measure of comparison. That the formula does not apply at points of contraflexure will be apparent from the following considerations.

The distance jd in the formula is measured from the centre of tension reinforcing to the centroid of the compressive concrete stress. There is no neutral horizontal plane with cracked tension concrete on one side and concrete in compression on the other side. The term jd, therefore, has no definite value which can be substituted into the formula. Furthermore, since there is no bending stress at either top or bottom of beam and the section is uncracked, the shear stress should be calculated for this condition which will give a different shearing stress from what is obtained by the usual formula for shear in reinforced concrete beams. If there is a crack, however, there is no way to determine where it will start or end since, generally speaking, there is no concrete in compression to stop a crack after it has started to develop. Since a partially cracked section is weaker than one uncracked, it seems most likely that the cracking when first started would continue completely through the beam. After this has taken place, the usual shear stress formula is even more useless than for an uncracked section because the concrete cannot transfer any shear from one section to the other along a crack.

If we want to find what the actual shearing stresses are at and near a point of contraflexure before any cracking has taken place, it is necessary to use the formula for homogeneous sections. This formula will give a unit maximum shear stress of $v = 1.5V/bh$ at the neutral plane of the section and the stress will decrease parabolically to zero at top and bottom of the beam. The presence of reinforcing steel may modify the stress to some extent. Investigations by Mörsch have thus indicated a coefficient of 1.62 instead of 1.5 where the bending moment is very low and

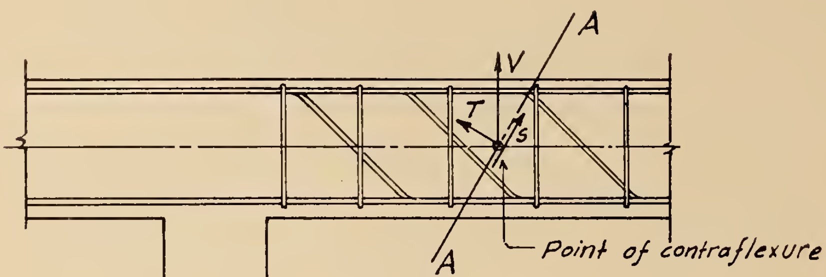


Fig. 5

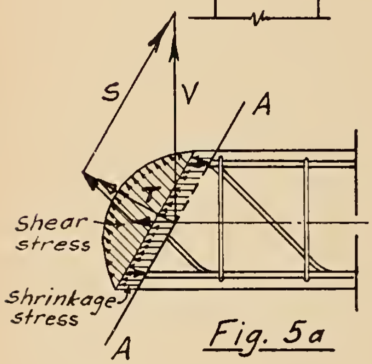


Fig. 5a

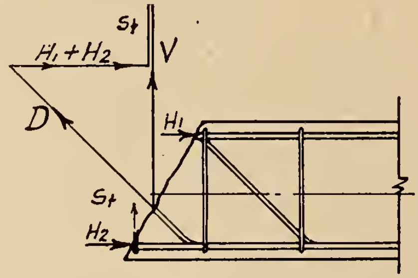


Fig. 5b

the concrete uncracked.[10] This small difference, which may in itself be variable, is hardly of any great importance. The important point is that the maximum principal tensile stress at points of contraflexure is not at the bottom or the top of a beam but rather at the centroid of the section. Furthermore, since the weak section for principal stresses is not vertical but inclined, there will be compressive stresses induced from bending both at top and bottom where the incline reaches the top and bottom surfaces. This again increases the tensile stress at the centroid of the section. However, where a crack will first start; at top, bottom or centre will likely depend on local weaknesses in the concrete.

If a through crack forms at a point of contraflexure neither the shear formula for homogeneous beams nor the usual shear formula for reinforced concrete will apply because there will be no shearing strength of the concrete left for transfer of shear across the crack. In a case like this the structural stability of the member depends either on the ability of the concrete alone to take the complete diagonal tensile stress or if the concrete cracks, the complete shear and longitudinal force must be taken by the reinforcing. Putting in web reinforcing for only two-thirds of the shear, for instance, is equivalent to expecting web reinforcing to carry one third extra stress after it gets into action due to formation of a through crack.

It is true that the positive and negative bending moments will increase relatively fast from a point of contraflexure. However, if we assume the weak plane in diagonal tension to be at 45 degrees (and it will be steeper in most cases), the distance available for getting concrete into compression will, at the most, be only half the depth of beam on each side of the contraflexure point. Since in the majority of cases there will be initial tension in the concrete due to restrained shrinkage, we cannot safely figure on any portion of concrete being in compression along the potential diagonal crack line. Furthermore, any increase in compression at both top and bottom of beam must create a corresponding additional tension on the centre portion so the average net result along the diagonal line will likely be zero.

The horizontal inward reaction in a rigid frame will be helpful, particularly in the end spans to put some horizontal compressive stresses intc the beam. Internal columns, if fairl rigid, will decrease this compression Interior spans will therefore, and be cause of axial shortening of the bean due to shrinkage and temperature de creases, be in the worst position ever if the shearing stresses are the same

It is hardly logical to assume tha T-beams require less web reinforcin than rectangular beams at points o contraflexure or at any other point for that matter. The only conceivabl benefit of the slab in a simple bean is that the slab in most cases reduce the compressive stresses below th allowable and that the slab may exer lateral restraint which increases th shearing strength. This latter condi tion only applies on one side at point of contraflexure. Any appreciable di rect help from the slab to carry th beam shear can hardly be counte on. The slab reinforcing running pa allel to the beam is thought to be help in resisting longitudinal force Such a help should not be require if the beam has been properly desigr ed. There are cases such as with sla and girder bridges, where the prac tice of cutting down on web reinforc ing in accordance with the A.C. code would appear to be most un justified and dangerous.

There is hardly any doubt that th most suitable web reinforcing at poin of contraflexure are the bent-up bar A crack at this position may be steep as 60 degreees and perhap even steeper due to the presence longitudinal forces.[11] In such case the shear distance adequately cove ed by a stirrup may be rather shor Bent-up bars will cover a greater di tance and will not be liable to de truction one by one to the same e tent as stirrups, which may be stri ped off progressively.

There is generally some initial i ternal stress in a beam caused l shrinkage. For a section containi reinforcing, this will cause compre sion in the steel and tension in t reinforcing. Assuming, for instance, shrinkage coefficient for unreinforc concrete of 0.0004,

$n = 10 \qquad E_s = 29{,}000{,}000 \qquad p = 1$

then

$$f_c = 0.0004 \times \frac{29{,}000{,}000}{10}$$

$$\times \frac{10 \times 0.01}{1 + 10 \times 0.01} = 105 \text{ p.s.i. tensi}$$

$$_s = \frac{105}{0.01} = 10{,}500 \text{ p.s.i. compress}$$

The coefficient of shrinkage here used is rather smaller than may be expected for indoor conditions and completely dried out concrete. On the other hand, there will be a plastic flow of concrete which will reduce the shrinkage deformation somewhat.

The length of beam will also decrease in accordance with the deformation caused by compressive steel stresses. If the supports are of a kind which will restrain such longitudinal deformation, the result will be a further increase in concrete tension. From the above example it is clear that the diagonal component from shrinkage will not be negligible, and when it is added on to the component from transverse shear, we might get into a situation where the tensile strength of concrete is overcome even if the nominal shear stress is not unduly high.

In summing up, let us now consider the combined stress condition at a point of contraflexure, Fig. 5. We will at first assume that there is no crack and that section A-A represents a potential plane of weakness perpendicular to the principal tensile resultant stress. The stress distribution on the portion of the beam to the right would then be about as indicated on Fig. 5a. If a crack now forms there must then be a redistribution of stresses if equilibrium is to be maintained since the shear component S will now be destroyed (assuming no dowel action). This new stress condition is shown in Fig. 5b. It is clear that the tension component T in Fig. 5a is causing the crack and not the shear component S, since concrete is relatively strong in shear.

be mandatory that a beam, when loaded to its ultimate capacity, should not fail in bond.

There is some difference of opinion of what the actual tension in a bar is near a beam support. It has been found by tests that when some of the bars are bent up, the remaining straight bars will have much less tension than would be indicated by the usual shear theory. Some European concrete specifications allow the bond stress to be calculated with inclusion of both the straight and the bent-up bars. German specifications allow the halving of the shear force for the portion of shear taken by bent-up bars, seems to be an additional reason for encouraging the use of bent-up bars.

The ordinary theory used for calculating bond stresses assumes two transverse sections one unit length apart. The bond stress will then be proportional to the difference in bar tension at the two sections. This assumption does not hold in practice, because cracks at critical points for bond and shear are not generally formed in a 90 degree direction to the neutral axis. It should also be understood that transverse stirrups can only take the vertical component of the shearing stress. The horizontal com-

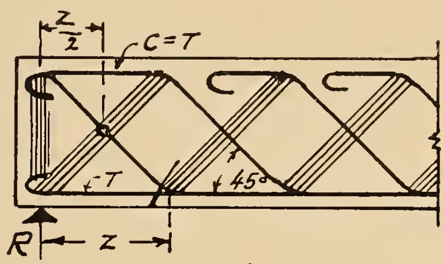


Fig. 6

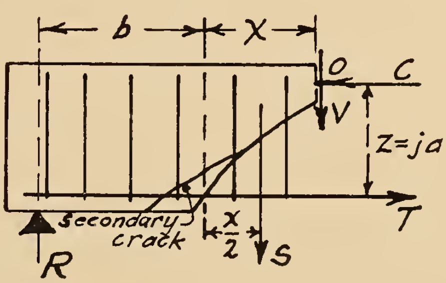


Fig. 7

Bond

The general acceptance of the improved type of deformed reinforcing bars has made possible a considerable increase in allowable bond stress. However, the increased bond stress will also increase the tendency of splitting. Allowable bond stresses have been determined on the basis of pull out tests where the concrete specimens were such that splitting was not too critical a factor. There can be little doubt that where splitting is prevented, the bond stresses allowed by the codes are safe. Reinforcing steel is in most cases, however, placed near the surface of a concrete member and we cannot, therefore, always expect to have a condition where it is safe to utilize the full allowable bond stress without using some other means such as stirrups to strengthen the section. Just as in the case of shear, it should

bars. This provision is based on tests carried out by Dr. Mörsch, who explains the reason for this reduction as follows: In Fig. 6 with moment about the intersection of the first tension and compression diagonals:

$$T = \frac{QZ/2}{Z} = \frac{Q}{2} \quad \text{and}$$

$$u = T / \Sigma O \quad Z = Q/2 \, . \, \Sigma O \, . \, Z$$

While a student at the University of Manitoba, the author participated in a beam test where the bond stress calculated for the straight bottom bars only appeared to be unreasonably high and he did not understand the reason for this until many years later. The fact that bent-up bars, besides being most effective as shear reinforcing, also decrease the bond stress in the remaining straight bars, seems to be an additional reason for encouraging the use of bent-up bars.

ponent must be taken by the horizontal reinforcing steel and will add to the tension in this steel over and above what is caused by bending alone. This fact has generally been overlooked and little attempt has been made to evaluate the additional tension in the main reinforcing. An analysis of a particular case of this problem was published by Dr. E. Rausch, and discussed by other German engineers in *Der Bau*, No. 1, 2 and 22 for 1949 and No. 5 for 1950. Rausch's solution is based on a crack forming at a 45 degree angle and that the complete shear is taken by the stirrups.[12] However, cracks do not always form at 45 degree angles and American codes allow some part of the shear to be taken by the uncracked concrete. A more general theory of which the Rausch formula is only a special case has, therefore, been worked out by the author.

In Fig. 7, assume a crack at an arbitrary angle. "S" is an arbitrary proportion of shear taken by the stirrups, while the rest is taken by the uncracked concrete in the compression zone at "O". Let us disregard the weight of the beam end itself, although it would be no difficulty to include this in the analysis.

With Moment about "O" we have:

$$R(b + x) - T \, . \, z - S \, . \, x/2 = 0$$

or

$$T = R \, . \, b/z + R \, . \, x/z - S \, . \, x/2 \, . \, z$$

from which

$$T = M_b/z + R \, . \, x/z - S \, . \, x/2 \, . \, z$$

For x = 0, that is, the crack being vertical, the two last terms of the equation disappear and:

$$T = M_b/z$$

which is in accordance with the accepted bending moment theory. There will be no excess bar tension for that case.

For x = z and S = R, that is, the crack being at 45 degrees and the complete shear is taken by the stirrups, we have:

$$T = M_b/z + R - R/2 = M_b/z + R/2$$

which is the Rausch formula.

If all the shear is taken by the concrete at "0", that is, there are no stirrups, and we assume the crack at 45 degrees or $x = z$, then:

$$T = M_b/z + R$$

It is seen that without stirrups, the excess bar tension is twice that given by the Rausch formula.

If x is greater than z, which may well happen if the top of a secondary crack joins the primary crack, and there are no stirrups, then, looking at the general formula, it follows that the excess stress may become much greater than the magnitude of shear "R". The formula can, of course, also be easily solved for any assumed proportion of shear taken by stirrups.

If we have no stirrups, it is evident from simple statics that the tension

$T = M_o/z$ will be constant regardless

of what the downward slope from point 0 is. If the slope becomes flatter, the difference between the stress in the bar at the crack, and just to the left of the crack, will become increasingly greater.

The apparent increase in bar tension where no stirrups are used, or only a part of the shear taken by stirrups, would indicate that it is desirable to use an ample amount of shear reinforcing.

It is rather disturbing that the above deduction plays more or less havoc with the accepted theory of bond stress as given in the text-books on reinforced concrete. Instead of a differential stress corresponding to the difference in moment tension at two points a unit length apart, we may have a unit differential stress near a crack corresponding to sections as far apart as the depth of the beam itself and even more than that.

Another conclusion which may be drawn from the analysis, is that caution should be used not to cut bars too short when stopping them beyond a point of assumed zero bending moment. On the whole, the bars may carry more stress near their terminal ends than has hitherto been assumed.

When a crack has formed, it is clear that bond stresses near the crack on both sides of it will be much higher than obtained from the usual formula.

This high bond stress together with dowel action will frequently cause formation of a secondary crack which may join the original crack higher up the beam. This may result in a practically loose piece of concrete being formed. If this should happen, the distance x, in Fig. 7 will again increase with a corresponding increase in bar tension.

Splitting

The bond or anchorage stress in the surrounding concrete caused by differential longitudinal bar tension will not only have a parallel component but also a stress component in the transverse direction. For smooth bars it is mostly near the terminal hook that such transverse stresses are high. It is quite a different case with a deformed bar which has anchorage along its whole length. The differential force must here be taken up at all points, and there will be little or no relief from sliding. The longitudinal differential tension in such a bar will have a considerable transverse component which causes a tendency of splitting of the concrete surrounding a bar.

It is not only the anchorage stress from a bar which may cause splitting, but there are also other factors which may have some influence. There can hardly be much doubt that shrinkage, shear, duration of loading and frequent load changes will also have considerable influences. How the bars are terminated may be of further importance.

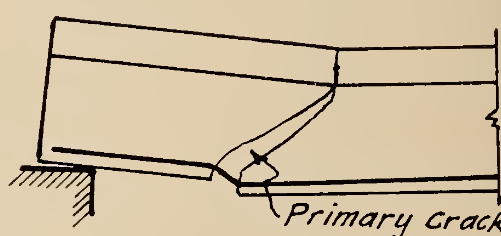


Fig. 8

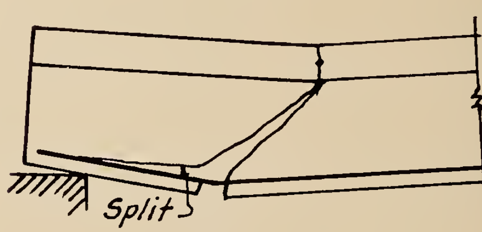


Fig. 9

Splitting may in many instances be caused by a combination of several influences, and one of these is shrinkage. It is clear that when a concrete body dries out, the shrinkage shortening per unit of length will be about the same in all directions. The transverse shrinkage will, evidently, tight-en the grip of the surrounding concrete on the bar with a corresponding transverse tension in the concrete. This transverse tension will then add to the component caused by direct bar tension. It is further clear that the larger the bar diameter is, the greater will be the transverse shrinkage tension. In fact, there is some similarity in this respect to the tension in the wall of a pipe under fluid pressure which will increase proportionally to the diameter. If a hair crack is formed first, it is also likely to be bigger and more dangerous for large diameter bars than for smaller sizes. When relatively large bars (or small effective bar spacings) are used in beam stems, as is not uncommon particularly in precast work, it would not be surprising if shrinkage alone could form fine, and perhaps at first, invisible cracks even before the member was placed. This condition is, of course, most likely to occur if the concrete is allowed to dry out before attaining sufficient tensile strength. The author thinks that the influence of shrinkage on splitting strength should be further investigated.

A second condition which will add to the transverse stresses, is dowel action of the main reinforcing at a crack. Figures 8 an 9 will indicate what happens when a crack has formed. The rotation of the parts on each side of the crack will create transverse tension in the concrete with a tendency to form a split along the bar, such as indicated. The author has seen such splits form both in tests in which he has participated and in pictures showing crack patterns of beam tests by others. The obvious means to minimize the splitting effect caused by diagonal cracking is to use more stirrups. It is true that a support reaction will act against the horizontal splitting stress. When the length of support is short however, the remaining uncracked portion at and near the support may not provide sufficient anchoring length. This transverse reaction force is not present at a point of contraflexure. For this reason a shear of equal intensity at such a point is more likely to cause failure than the same shear at the freely supported end of a beam.

A third and fourth condition which may influence the splitting strength are loadings of long duration and repetitive loadings. It is reasonable to assume that splitting strength under such conditions would decrease at least as much as compressive strength does. Since splitting resistance depends mostly on tensile concrete strength, it is even possible that the relative strength would be less for splitting. The author does not know if these conditions have been investigated.

Investigations in the U.S.A. indicate that deformed bars of larger cross section do not have the same bond value as smaller bars. German investigations with smooth bars have shown that for ordinary conditions and bar spacings bond stresses do not become critical for bar diameters less than one inch.

The splitting question is now receiving much attention, partly due to some failures of structures whose design complied with the A.C.I. building code. Interesting and instructive tests have been carried out at the University of Texas.[13] These tests, however, do not take into consideration the effects of shrinkage, loading of long duration, and repetitive loadings. The influence of dowel action may not have been adequately considered in the evaluation of the test results. More testing to determine the influence and magnitude of these secondary effects is certainly desirable.

Termination of Bars on Tension Side

At the beginning of the use of reinforced concrete in Europe, it was customary to terminate bars with hooks on the tension side of a beam when such a bar was not required for moment tension. The practice seemed to be justified by a certain analogy to the termination of a cover plate on a steel girder. It was brought out during extensive German tests that long before the ultimate loads were reached, large cracks would usually form at the end of the hooks where there would be a sudden change of stresses. Based on these findings, the termination of larger bars in a tension zone has either been forbidden by European codes or is considered to be very poor practice. It is rather surprising that such construction seems to be increasingly acceptable in this country. Omission of hooks is not likely to eliminate cracking at terminal ends of bars completely. Pictures of tests of lapped bar splices may be indicative in that respect.[14]

Conclusions

The discussion in this article would indicate that a general strengthening of building code provisions for web reinforcing is necessary. It is also shown that anchorage stresses in bars may be much greater than obtained by means of the usual bending moment theory. An inescapable conclusion, based on the material and information available, is that our reinforced concrete building code is in an immediate need of revision as far as specifications for shear reinforcing is concerned.

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Future Annual Meetings

1958

Quebec, Chateau Frontenac, May 21, 22, 23

1959

Toronto, Royal York Hotel, June 8, 9, 10

Selection and Training of Second Line Executives

Report of a panel discussion at the annual meeting of The Engineering Institute of Canada, Banff, Alta., June, 1957.

Chairman: B. A. C. Hills, M.E.I.C., President, Urwick Currie Limited, Montreal.

The Panel: A. L. Bishop, M.E.I.C., President, Consumers Gas Ltd., Toronto.

R. A. Emerson, M.E.I.C., Vice-President Operations & Maintenance, Canadian Pacific Railways.

D. M. Stephens, M.E.I.C., Chairman and General Manager, Manitoba Hydro-Electric Board.

W. H. Young, M.E.I.C., Manager, Chemical Metallurgical Division, Sherritt Gordon Mines Limited, Fort Saskatchewan.

THE CHAIRMAN pointed out that the members of the panel would be considering particularly second-line executives, that is, men who have gone from functional management (management of a particular functional department such as engineering, accounting, and so on) to *general* management, or whose next step upwards will be into general management. The step was a particularly difficult one because it called for different techniques, a different approach to tackling problems. For example, an engineer must forget his production bias and think in terms of the overall objectives of the enterprise. As a general manager he must co-ordinate subordinates who talk about sales, finance, production, accounting, and so forth, whose language is peculiar to the various professions involved and whose viewpoints are strongly biased and sharply conflicting because of the differing roles that each of them play in the organization.

The panel were then asked their views on the following:—Bearing in mind that they were considering men who were to be moved from functional to general management as previously defined, what were the qualifications, the abilities and other criteria which should be the guiding considerations in selecting second-line executives. All the panelists stressed the need for leadership and initiative. Mr. Young considered that technical qualifications were not important; Mr. Bishop disagreed and also stressed the "trustee" nature of the job Mr. Emerson pointed out that the general manager's job was not always palatable; and Mr. Stephens looked for success in previous posts as a necessary qualification; he also required ability to analyze problems.

The second question was, "How many of these qualifications and abilities can be taught and what form of training would achieve this? At what period in the potential general manager's career should this training be given?" There was unanimous agreement that training for general management was a continuous process which began on the first day a man entered industry; Mr. Emerson thought that even leadership could be taught? he favoured transfer from line to staff positions periodically at all levels so as to give the man experience in handling men of other professions as well as broadening his outlook; special assignments to "trainees" were also important from an education viewpoint.

Mr. Stephens stressed the importance of "charting the course" of each potential manager; he described the procedure adopted in his own company and said that the company *must* provide opportunities for learning. He considered that the technical side was one that required most training.

Mr. Bishop endorsed the point made relative to planning the progress, and thought that the "assistant to—" position served a very good means of training a general manager. He instanced conferences, seminars at universities, night schools and management consultants as sources of learning about management. He thought the public relations aspect of the general manager's job was important and referred to the advantage of a pleasant voice in this respect.

Mr. Young believed that training could be given in practically every requirement of a general manager; he also thought that transferring a man to other departments so that he took on a different kind of work was essential training. He warned of the danger of selecting a man for promotion before he was ready for it, and said that this was particularly to be guarded against in the smaller companies.

The panel was then asked to say who should be responsible for management training—the company, the individual, or both? Who should in fact pay? There was unanimous opinion that both should be responsible, but thoughts were divided as to who should pay. Mr. Emerson thought the company should pay, but Mr. Bishop spoke of the psychological advantages attached to the individual paying for his own education. Mr. Emerson pointed out that the individual was still required to show initiative regarding his own training, and the company continued to support financially the man's aims only so long as he took full advantage of the opportunities given to him. Mr. Young warned against the in-

(*Continued on page 1628*)

DISCUSSION

of Technical Papers and Other Articles

F. M. Kraus, M.E.I.C. *

Thanks are due to E. M. Rensaa, author of the article on Ultimate Strength Design. It is obvious that the concepts of reinforced concrete have been studied thoroughly, and from different viewpoints.

It is to be expected that a change in design methods will meet with criticism or resistance as ideas and methods in current use have become well-entrenched in the minds of many engineers. It might therefore be opportune to take the side of the new trend in order to stimulate thought and clear the issue.

It is conceded by the author that ultimate strength forms the basis of the plain section calculations as much as it does for the ultimate strength method; it is also conceded, in the same article, that Hooke's Law in reality does not apply.

As long as the discussion is confined to bending, as set forth, the concept is plain, and can be illustrated in the light of the general theory of elasticity of homogeneous materials, allowing this for the purpose of discussion to stand for concrete within limits of elastic behaviour and working loads. If this is accepted, then the main practical implication of the ultimate strength design method seems to lie in some saving of steel, yielding more "underreinforced beams", which seem desirable, as more economical and giving warning of collapse.

Furthermore, the ultimate design does not apply to the whole length of beam, frame or arch, but only to the section or part subject to maximum bending moments.

Now, if this section of maximum strain is designed in accordance with a parabolic or similar strain, i.e., stress distribution, then firstly it will be covered by a safety factor, and what is adequate for ultimate strength should be satisfactory for reduced strain and stress distribution. Secondly, such stress and strain is localized, and is therefore subject to provisions dealing with increased resistance of the concrete under lateral confinement.

In view of the uncertain values of the elasticity modulus and the change with age of the concrete, the character of loading, etc., it seems justifiable to part with the concept of its use for strength design. It may also be noticed that plane sections are never really planes in any material under any loading, regardless of what slenderness ratio or shape of element is used, and are probably least so in concrete.

I have had an opportunity to carry out fairly extensive testing on various test beams, and the deformation of cross sections, where detectable, conformed closely to those outlining curvatures of 'plane sections" in the text dealing with elastic stability or theory of elasticity. I might add that some of those test beams were made of laminated timber and concrete — two materials which are not isotropes in fact.

I subcribe to the statement that ordinary textbooks do not cover the subject adequately. But such textbooks are basic education only and as many engineers know, there is a giant step between theory and practice. There is ample evidence, however, that successful and thorough testing has been carried out, and that the theory of ultimate strength is not new at all. The information is available to the professional at any time.

As far as the T-beam is concerned, a very simple device, applicable as an approximation has (probably unnoticed) been using ultimate design practices, and with success. If the lever arm between centre of gravity of steel to centre of gravity of slab is applied to bending, justice is done to the ultimate strength design. The uncertain distribution of strain between the beam web and the slab and also in the slab itself on both sides of the beam is, in effect, much more serious than the steel reduction resulting from the simplified formula approximating the ultimate strength method.

Balanced beams, where steel and concrete are expected to fail at approximately the same load, are likely to cause trouble no matter how they are designed, as these structures may tend to be of the shallow type and the static deflection could increase several times due to creep, plastic flow, or cracking.

The concrete mass and its inherent shortcomings of fabrication and placing are covered by safety factors to a certain extent, and to strain readjustment for the balance. Where concrete strength in the structure is inadequate it will be so as much for beams designed by conservative methods as for the ultimate strength design.

In the design of structures, assumptions of span, fixity, loading and support are very often made which are necessarily at variance with the natural behaviour of the design grid. Would it not be illusory to dwell on pure theory only when this same reasoning is incapable, under practical application, of encompassing the intricate natural balance of the structure? Is it therefore reasonable to continue the use of a method of design which has been recognized to be academic at the very outset of its application, or is it not better to use a method which we have found to be closer to what really happens in a

*Consulting Engineer, Montreal.

structure. It seems that it would be a forward step to recognize the behaviour of the materials we are using, and act accordingly.

Elmer Brooker, Jr.E.I.C. †

The writer has read with interest Mr. Rensaa's discussion on ultimate design. His conclusion that there is not much benefit to be gained by using ultimate design methods for normal sized building members is correct. But only because the design percentage of steel allowed by the present triangular stress block method cannot be exceeded without causing an undesireable simultaneous or compression failure under ultimate load conditions. It can readily be shown that if a simultaneous failure is designed for by ultimate design methods the critical percentage of steel will lie in the neighborhood of 4.0%. This percentage of steel is not easily placed in concrete beams of usual sizes. For a tension failure in which the reinforcing steel yields when the extreme fiber stress of the concrete reaches its maximum value the critical percentage of steel is about 1.2% The latter percentage of steel may be readily placed and is very nearly the same as the triangular method allows. From this aspect the triangular method is therefore acceptable for ordinary construction.

Actually, ultimate design could afford a considerable saving in heavily stressed members by a reduction in dead load, if undesireable deflections did not result. In ordinary construction the beam sizes cannot be reduced without causing excess deflections.

The following arguments speak very strongly for ultimate design methods. Concentrically loaded columns are esentially designed by ultimate design methods now, and the factor of safety against failure in these columns is in the range of 3.5 to 4.5 depending upon the percentage of steel and strength of concrete used. There is evidence that the ultimate shear stress may be as low as 0.3 f'_c; however, the present Canadian Building Code allows an allowable shear of 0.3 f'_c before web reinforcing is required. Therefore it is apparent that the present Building Code has a varying factor of safety. By the use of ultimate design methods in research the factor of safety and mode of failure may be investigated and a sound basis for future codes established. It is desirable that we have a consistent factor against failure in all calculations whether it is compression, flexure, shear or bond.

Ultimate design calculations do, at present, have a place in practice. In prestressed concrete members enough steel may be placed, due to high allowable steel working stresses, to cause a compression failure. In this case ultimate design is practical and convenient. There are other special cases where ultimate design can also be useful. Although its use is not recommended for most ordinary work, research based on ultimate design provides a better understanding of the true behaviour and factor of safety of regularly designed reinforced concrete members.

Ultimate design calculations can be as simple as triangular methods. For example, C. S. Whitney's method as prescribed in the latest A.C.I. Building Code. A more accurate but just as convenient method is the use of V. P. Jensen's stress block and Hognestad's ultimate strain of 0.38%. This method is used in research by Dr. R. N. McManus at the University of Alberta. It is the writer's opinion that a sound discussion of ultimate design methods should include its usefulness in (1) understanding the various modes of flexural failure (2) investigating compression, shear, bond and other types of failure, and (3) forming a sound basis for the selection of working stresses and factors of safety.

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Author's Reply

The author is grateful to Messrs. F. M. Kraus and Elmer Brooker for their discussions. Since these discussions deal mostly with general principles, a reply common to both discussions on this basis may be made. The author thinks that the following conditions should be considered before our present design method is abandoned:

A properly designed structure should not fail and a sufficiently large safety factor should be used to insure against such an occurance. This safety factor is generally based on tests of strength of the kind of materials and combinations of materials which are to be used in the structure. The actual stress variations in the materials will then be those corresponding to the range of loading from a minimum to a maximum. It is therefore incorrect to say that some other stress distribution corresponding to the more remote overload condition to absolute failure is more in accordance with actual facts.

Another question to be answered is what should be considered a failure. Is the failure a condition when some part of the structure has been overloaded to such an extent that permanent damage, impairing the further usefulness, has been caused even though the structure is still standing. Or is the ultimate strength to be that which corresponds to a collapse. It is presumably on basis of the latter assumption that some writers advocate the use of "Plastic Hinges" in reinforced concrete structures. The author thinks that a designer will be well advised to avoid a structural condition where either the steel has been stressed beyond its yield point with a resulting visible crack or where concrete has been stressed so as to crush or spall. It is very unlikely that an owner will be impressed or satisfied with any kind of an explanation justifying cracks or spalling even if the structure does not fall down. Beside the not unimportant question of psychological effect, we also have to consider the effect on durability, and cracks may be very detrimental to this in many instances.

If we accept the principle that no kind of damage should be visible, we shall have to make sure that such will not occur even with some overloading. We are then back to the old principle that there must be a safety factor applicable to conditions of use and that a single alternative safety factor relating to ultimate collapse only is not generally sufficient.

If the ratio between damage strength and ultimate strength had been constant or nearly so for different structural elements, a common safety factor relating to both conditions would have been quite convenient. That, unfortunately, is not the case in a number of instances. As an example, columns may be mentioned. The spirally reinforced

(*Continued on page 1480*)

† R. M. Hardy and Associates Ltd., Edmonton, Alta.

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

NEW SOURCES OF PROPULSION ENERGY

H. Harvey *S.A.E. Journal*, v. 65, n. 9. Aug. 1957

Aircraft and missiles, which seem to be becoming one and the same thing, have a limitation on their performance based on the amount of energy in the form of fuel that can be carried. Greater speed and greater range are required for the future and for these reasons the hunt for new sources of energy is on. For over half a century petroleum has been the source of energy for the aeroplane. As convenient, clean and economic form of energy it has had no equal, and its versatility has made it the ideal fuel for all types of engines, spark ignition, compression ignition, turbine and ramjet. It will be difficult, if not impossible, to find any fuel that can compete with it on a cost per pound basis.

However, aircraft and missile designers are now looking for fuels which surpass existing forms both on an energy per pound and an energy per gallon basis since weight and volume limitations are always critical factors. Various chemical compounds are being investigated as fuels for air-breathing engines or as propellants for rocket type power plants, without cost being the determining factor.

On a basis of heat release per unit weight hydrogen is by far the outstanding fuel, having almost three times as much available energy per pound as kerosene or gasoline. Unfortunately, there are insuperable handling problems. Hydrogen must be compressed if it is to be stored and transported as a fuel, and massive equipment for containing high pressures is required. Even if a practical solution to mechanical difficulties could be found the results would be disappointing because the heat content per unit volume is very low. At 2000 psia. and 60F. the density of hydrogen is 0.093 lb. per gal (U.S.) and the heat content 4780 B.t.u. per gal. Roughly, this is about a 17 times larger fuel volume than presently required by aircraft using gasoline.

Although hydrogen by itself is not a practical high energy fuel it shows promise as a main component. Considering aviation gasoline and taking a typical eight-carbon-atom molecule, about 40 per cent of its energy can be attributed to hydrogen and 60 per cent to the carbon content. The carbon, however, contributes 84 per cent of the weight. One approach to producing a high energy fuel would be to replace the carbon atoms in the hydrocarbon molecule with an element having a higher heat release per unit weight than carbon. Beryllium, an alkaline earth, has a B.t.u. content per pound higher than all elements except hydrogen. Unfortunately, it does not combine readily with hydrogen, it is quite scarce and it forms compounds which are toxic. On the other hand, boron, a nonmetal, and lithium, an alkali metal, form hydrogen compounds or hydrides which show promise and are presently under investigation.

Boron

Boron is a stable substance and does not burn below 700C. At the same time, it is extremely abrasive and would probably have to be burned in an afterburner or ramjet where it would not damage turbine blades. Probably it would have to be used as a slurry in kerosene. Its heating value is 25000 B.t.u. per pound and it has a very favourable volume to weight ratio.

The chief interest in boron at this time, however, appears to be as a carrier for hydrogen in place of carbon. These carriers are the boron hydrides like diborane, septaborane and decaborane. On a weight basis these fuels have a heat content up to 70 per cent greater than kerosene. Their synthesis is not easy, diborane being prepared from lithium hydride and boron trifluoride etherate. Diborane is a toxic gas which is unstable in the presence of aid or moisture. Since decaborane is a solid it can be presumed that a practical boron hydride will contain about five boron atoms. Some success is reputedly being obtained in stabilizing fuels in this range and reducing their toxicity by alkylating them. Eventually it is hoped that processes will be developed which will bring the cost of boron fuels down to a dollar or less per pound. Bomber aircraft are presently being designed on the basis of using boron derivatives as fuel.

In the rocket field air is not used as the oxidizer. Nitric acid, hydrogen peroxide, and ozone are favourite substitutes for oxygen and there is at least one high performance aircraft flying today that uses nitric acid and kerosene as the fuel combination. Fluorine is much superior to oxygen as an oxidizer and in combination with diborane gives a high specific impulse (i.e. pounds of thrust available per pound of propellant consumed per second). Fluorine is toxic and expensive as well as being very corrosive. Because it is a gas it must be stored under pressure in containers of nickel alloy. The cost is about five dollars per pound but with greater demand it could probably be produced for about one dollar per pound. Ozone is an even more powerful oxidizer and with hydrogen it produces a much greater specific impulse. One big drawback in the handling of pure ozone is that it tends to decompose with explosive violence, however, progress is being made in handling the pure product in a stable form.

A still more spectacular source of energy, hitherto untapped, is the harnessing of energy inherent in free radicals. A free radical is a molecular fragment free of any electrical charge which is formed usually during an exothermic reaction. The upper atmosphere is a reservoir of free radicals formed as a result of the sun's radiation. They are suspected of being responsible for some of the radiation in the aurora borealis. They are also found in the exhaust gases of internal combustion engines and in flames. Since they are formed by the absorption of energy they are energy reservoirs. Free radicals are a transient state of matter lasting usually only a fraction of a second and are not fully understood. Recently techniques have been developed to 'freeze" their existence and isolate them for further investigation. Free radicals of nitrogen, oxygen, hydrogen, water vapour, and ammonia gas have been collected as solids at temperatures of about 4K. When heated to 20 or 30K. they combine releasing what are referred to as vast quantities of energy in the form of radiation and heat. It is estimated that a fuel composed of 100 per cent hydrogen in the form of free radicals would have a specific impulse five to six times greater than that of conventional type fuels. While the problems of manufacturing, storing, handling and controlling disassociated hydrogen are formidable, less active forms, such as the isolation and stabilization of the ammonia radical in liquid hydrogen, show more immediate promise. This system at moderate temperatures could give a nine-fold increase in range over present rockets.

COMPETITION FOR STEEL WORK

Civil Engineering, v. 52, n. 613, July 1957

Increasing use of wood as a structural material in Great Britain is becoming evident in the applications of laminated timbers to recent construction projects. A recent survey has been made of the European practices in wide use over the last fifty years. In Europe glued lamination is not only carried out by big firms but it is also done quite profitably in factories equipped with modest plant using a small labour force. By comparison with the American lamination industry which has been able to introduce mass production methods, the making of laminated members in Europe is still largely a craft affair. Mechanization does not, in general, extend beyond the machining of laminates and, so far as is known, there is no factory on the continent offering a range of standard components "off the shelf". Neither does there appear to be national standards for laminated components or preferred dimensions or shapes.

Economic as well as technical considerations appear to exert a decisive influence on design. Laminated straight beams and girders are much favoured in Switzerland. European fabricators as a whole avoid small radii as far as possible in the construction of laminated arches and other curved members. In Holland and Belgium I-section arches and portal frames are much in vogue, largely because they combine structural efficiency with timber economy. By comparison, a rectangular laminated section of equal moment of inertia calls for about 25 per cent more timber.

A Swiss development is that of grid lamination in which the grid is made to support either a plain or a curved roof. The grids are prefabricated in sections of about 10 ft. x 20 or 30 ft. and larger. The largest spans so far achieved by European laminators with arched portals are about 160 ft. but spans up to 230 ft. and over are being considered.

From studies made in Holland and Belgium it is estimated that for spans over 35 ft. laminated timber construction is competitive with reinforced concrete and steel. In these two countries prestressed concrete is regarded as the most serious competitor. Laminated timber producers in the Netherlands claim that large spans of 100 ft. or more can be supplied for as little as half the price of reinforced concrete. Swiss firms, also, claim that laminated timber is fully competitive once spans of 40 ft. and over are reached, and is invariably cheaper to use for really large spans.

PIGMENTS IN POLYMER MATERIALS

J. F. Ambrose, *Bell Laboratories Record*, v. 35, n. 7, July 1957

Since early times man has modified his natural materials by incorporating into them finely divided substances to impart desirable properties. Chopped straw was baked into clay bricks for added strength, then masons added fine sand to slurries of lime to make a hard strong mortar which was similar to that used today. In modern plastics technology, the use of additives to alter and improve the basic properties of both natural and synthetic polymers has proved to be very important. These new materials have in many cases replaced their naturally occurring polymeric prototypes — rubber, wood, textile fibres, leather and even furs, and indeed are also superseding in many applications inorganic materials such as glass, metals and alloys.

In the Bell System today, plastics replace only the materials that they can clearly surpass in desirable characteristics. The success that has been obtained has derived from the fact that properties not originally present in the plastic may be added, or undesirable properties ameliorated or removed. This is done by materials added to the polymer, sometimes in infinitesimal proportions, but often as a major component of the mixture. One of the largest classes of such additives is the pigments, finely divided materials which are insoluble in the base material.

The properties of pigments which give rise to their usefulness in polymer compositions are many and varied. The compounder has need in some cases for their thermal and electrical conductivity, in others for their magnetic susceptibility. The properties deriving from their finely divided state — such as increased light absorption, enhanced chemical reactivity and surface dependent properties (adsorptivity, for instance) — are often of paramount importance.

One of the largest uses for pigments-filled polymers in the Bell System is in polyethylene cable sheath. When being used on a telephone pole a polyethylene cable sheath not containing carbon black could be expected to last about a year. With two per cent by weight of fine particle carbon added the life increase to twenty years. In this application the pigment acts as a light screen absorbing the ultraviolet radiation in sunlight which would otherwise rapidly degrade the polymer. Similarly pigments are used for protection of polyvinyl chloride wire coverings and fillers for colour-coding. Rutile titanium dioxide is the additive. Silica is used as a filler in polyester casting resins used for encasing electronic components for protective purposes, often in amounts up to 50 per cent by weight. It reduces the shrinkage when the resin cures and it provides adequate thermal conduction for the heat generated by the "potted" components when in use. The property of reinforcement is probably the most significant contribution of pigments to modern polymer technology. With the use of carbon black in rubber and other elastic polymers, the mechanical properties such as abrasion resistance and tensile strength are remarkably improved.

Economic considerations underlie a great number of the applications of fillers in polymers; carbon black, for example, costs much less in a compound than the polymer it replaces. Similarly, clays and other mineral fillers utilized in tapes, drop wires and neoprene jackets for wire, cost only a small fraction of the polymer replaced.

Future developments in the use of particles in plastics will be numerous. Luggage of polyester materials is now produced on which a new finish may be applied, to mars and scratches merely by rubbing with steel wool. Similar finishes in plastic-bodied sports cars and boats wait only the adequate standardization of pigment colours. Glass fibres of refractive index closely matching that of the binding resin are being fabricated into transparent, reinforced building panels in many colours. Dies for the fabrication of massive metal parts, such as automotive bodies, are constructed by casting metal-filled resins, rather than by machining from steel. Considering the enormous strides made in metallurgy by alloying a limited number of metals it can be expected that similar great advances will result from the incorporation of the great variety of particulate materials into the large number of polymers.

HOW TO USE TAPE CONTROLLED MACHINING

M. Kanes and C. B. Sung *The Tool Engineer* v. 39, n.2. Aug. 1957.

Recent developments indicate that the use of tape control of manufacturing processes will rapidly increase. Announcement has been made of the completion of a large milling machine for a major aircraft firm, designed and built with a numerical control system. A tape controlled three-dimensional cam machine has been in successful operation at an aircraft accessory plant for over 12,000 hours. However, it should be realized that certain types of machining operations are more suited for automatic control than others.

The development by the Bendix Aviation Corporation is an integrated manufacturing system. Its main elements are a computer for automatic processing of engineering and maching information, a machine tool designed for automatic operation from a punched plastic tape, electronic and hydraulic controls to translate the recorded machine instructions from the tape accurately and rapidly into drive motions of the machine slides, and finally, digital feedback instruments coupled to each machine slide to accurately measure the relationship between cutter and workpiece at each instant throughout the operating cycle.

Considering possible applications, the aircraft industry affords an immediate area for tape controlled machining particularly in milling operations. The tremendous advances in military aircraft performance during the past few years have been accompanied by radical changes in manufacturing techniques. The advent of new materials, coupled with increased emphasis on weight reduction in the airframe, has replaced many sheet-metal assemblies by intricately sculptored machined parts. Forged and cast fittings which formerly were partially machined are now finish-machined to closer tolerances in order to eliminate the last ounce of dead weight. The immediate application of tape control in the automotive industry appears to be in the making of tools and dies rather than parts. Tape-controlled die-sinking machines can reduce the high cost and long lead time involved in making many automotive body and forging dies. Advantages of tape controlled machine tools are: ability to fabricate parts of complex design previously not feasible; reduced set-up and—or machining time reduced tooling cost and lead time; better finish or accuracy; increased versatility; alleviation of the skilled operator shortage.

A broad and important category of tape-control applications in industry is therefore the machine tools used mainly on short run jobs. The simplification of tooling and reduction of set-up time eases the problem of change-over from one small job lot to the next. In this case, as in the toolroom, where versatility has been the key factor in machine tool utilization tape control appears to hold extensive promise. This field of application may be thought of as the low production type of automation, in contrast with the form of automation found in mass production such as is seen in the automotive industry. Tape controlled machine tools should prove to be a practical asset even in the smallest jobbing shop.

The system is much simpler than has been generally anticipated. No large staff of mathematicians or specialists is needed. The function of the tool engineer remains unchanged. He provides the basic manufacturing information in a numerical form suitable for machine control, in addition to designing tooling suited to the system. His job becomes more important since complete manufacturing engineering replaces skills formerly furnished by the machine operator.

Digital computers, which are finding increasing use in industry for scientific and business applications, are adaptable for preparation of control tapes. The function of a computer in evolving a numerical control tape is to generate sufficiently detailed tool path information from the relatively few dimensions given on the blue print, to produce continuous control of the machine. Fundamentally, computations entail determination of the cutter path based on specified cutter size, and piece-part dimensions, and interpolation of specified curves to yield a sufficient number of intermediate control points. Any general-purpose digital computer is capable of handling this type of numerical data processing to produce the required results in numerical form from input instructions also expressed in numerical form. The numerical output of the computer may be recorded directly in code form on punched cards or tape.

Tape preparation starts with the process engineer who prepares a process data sheet containing key dimensions obtained from the part drawing, and machine process information including cutter size and feed rate. A straight line section on the part is defined on the process sheet by two lines designating the start and finish points respectively. In the case of a curved section such as a circular arc, the arc radius is specified in addition to the start and finish points. Provision is also made on the process sheet for designating the tolerance required on curves.

The completed process sheet is next copied by means of a clerical typing operation which simultaneously produces a type-written copy of the process sheet and a punched tape which contains the processing information in a form acceptable to the computer. The process tape is read by the computer which automatically produces the control tape in the form required for machine control.

The method is versatile so that numerous sub-routines can be employed. Completely general two and three-dimensional programs include the ability to handle any analytically defined curves, as well as pocket-milling and profile-roughing operations. Consequently, the need for tedious hand computation by the process engineer is eliminated. A tooling or process engineer can be trained to use this system in less than one week.

The punched control tape is a compact recording of the coordinated movements of the machine slides required to maintain the changing relationship between the cutter and the workpiece. In addition, the tape contains instructions for cutter feed rate, auxiliary control functions, and checking information. The binary instructions for each controlled motion are converted into a train of electrical pulses each representing a command for the machine slide to move a specific distance. A pulse value of 0.0002 inch is usually emploted although this value can be smaller if desired. Each machine motion is provided with a rotary digital feedback instrument that measures the actual movement in increments of 0.0002 inch. The accumulated difference between command and feedback pulses is converted to an analog signal which is fed to the hydraulic servo-drive unit. This provides extremely fast and accurate response of the machine to input electrical commands. Consequently the machining operations can be controlled to produce much higher speeds and accuracies of metal removal than is possible in a conventional hand-operated machine.

An example of the advantages is illustrated in the machining of a rough forging which was required to be finish machined on the outside and inside profiles. The tooling program for conventional processing using a tracer-controlled machine tool involved a total of 210 hours, including the time for design and manufacture of a holding fixture, a boring fixture and a complex set of tracer templates. In comparison the tape controlled tooling program required 92 hours, the boring fixture and templates are eliminated, and the finish is considerably better than that obtained conventionally.

TESTING METALS "ON-THE-FLY" WITH EDDY CURRENTS

R. Hochschild, *Control Engineering*, v.4, n.8, August, 1957

Due to the need for greater reliability in engineering materials which are being subjected to increasingly higher stresses and more rigorous environments, and because sampling techniques necessary with destructive testing often prove unsatisfactory, a great deal of development work is taking place to produce methods which permit 100 per cent inspection of materials on the production line. Several types of instrumentation including radiation, ultrasonic, magnetic and electrical devices are suitable for such "on-the-fly" inspection.

One method is eddy current testing which is quick, readily adaptable with electronic control circuits, and suitable for checking characteristics of several materials in addition to seeking out mechanical flaws. Minute eddy currents induced by a radio frequency field explore the material and can be made to yield information on dimensions, on the presence of flaws or on mechanical, metallurgical, and chemical properties. By means of suitable controls linked to the eddy current instrumentation defective material or parts can be rejected, sorted, or labelled. Eddy current equipment is also very adaptable for continuous adjustment of the production process through a feedback-control loop.

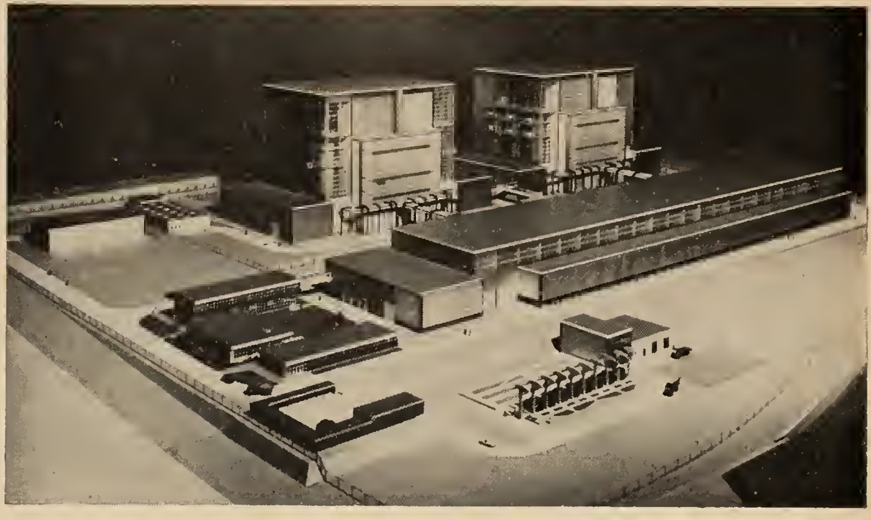
Several conditions affect both the magnitude of eddy currents and the paths they follow within a particular piece of metal. One such condition is the resistivity of the metal which depends on many microscopic phenomena. Some of these phenomena relate to the strength, hardness, alloy composition, chemical purity and crystalline condition of the metal. Consequently eddy currents may give some knowledge of these properties.

A second group of conditions to which eddy currents respond are discontinuities and boundaries that influence their flow pattern. Examples are cracks, holes, laps, seams, and porous areas. The detection of such defects in metal objects of relatively uniform shape has been one of the principal fields of eddy current testing, often replacing older methods of visual, powder particle, penetrant, and radiographic inspection.

Eddy currents have many of the properties of a compressible fluid. They flow in certain patterns and distributions determined, first, by the design of the test coils which set up the radio-frequency waves, and second, by the frequency of oscillation of the waves. The frequency, in particular, controls the depth to which eddy currents penetrate the surface. Higher test frequencies are used to inspect surface regions, while lower frequencies deepen the penetration into the part but at a sacrifice of sensitivity to surface defects. At any given frequency the amplitude of the eddy current falls off with increasing depth and so does the test sensitivity, therefore the method is more suited for surface and near-surface zones than for interiors. The lagging phase angle of the current increases with depth, thus providing a basis for measuring the depth of a flaw. Also the phase angle behaviour makes it possible to determine whether an indicated defect is actually a flaw or a conductivity or a diameter change. Currents encountering an obstacle such as a crack are detoured around it, being compressed and weakened in the process. The current induced by the applied r-f energy in turn sets up its own magnetic field. The resultant field external to the part being tested contains information on the position, shape and size of any discontinuity distorting the currents and it can be analyzed electronically to yield this information in a useful form.

A third condition influencing eddy currents in a given part are the dimensions of that part. This has led to development of sensitive equipment to determine and control the dimensions of manufactured products such as rods, tubing, bolts, pistons and ball bearings, the thickness of sheet, plate, strip or foil of one metal plated or coated on another; and the thickness of insulating coatings on metal surfaces. Measurements accurate to better than a millionth of an inch can be made from one side only and without contacting the part.

Like x-rays, eddy currents leave no after effects in the metal. The greatest difficulty in their use is that they are very sensitive to a great many variables. However, the instrumentation can be designed to be sensitive to a limited number of conditions only through the use of phase sensitive circuits, proper test frequency and test coils of special design.



LARGEST ATOMIC POWER STATION

Work is due to start on what will be the world's largest atomic power station. It will have an output of 500,000 kw. and will occupy an area of some 25 acres. The station will have two reactors of the gas-cooled graphite-moderated type fuelled by natural uranium. Each reactor will consist of a 24-sided core of graphite blocks with a lattice of vertical channels containing the natural uranium fuel elements, and enclosed in a spherical pressure vessel 67 feet in diameter. The pressure vessels will be fabricated by welding on site from pre-formed mild-steel plates three inches thick. Fuel charging, from the top of the reactors, is to be done on-load to permit a continuous refuelling cycle. Each reactor will be connected to six steam-raising units (heat exchangers), grouped in three on either side of the reactor. The twelve units, each 90 feet high and 21 ft. 6 in. in diameter, will generate over 5-1/2 million pounds of steam per hour. The units, which are of the double-pressure design originated for the Calder Hall installation, have been developed so far that each has a capacity three and a half times that of a Calder Hall unit, although the height and diameter are only 20 per cent and 25 per cent greater respectively. The electrical power output at Hinkley Point will be generated by six 93,500 kw., 3,000 r.p.m. hydrogen-cooled turbo-alternator sets; three 33,000 kw. variable speed turbo-alternators will also be installed to supply power for the gas blowers. The station is to be built by the atomic power projects group of The English Electric Company, Limited, Babcock and Wilcox Limited and Taylor Woodrow Construction Limited to the order of Britain's Central Electricity Authority and will be at Hinkley Point in Somerset.

THE INTERNATIONAL GEOPHYSICAL YEAR

Much publicity has been given to the advent of the International Geophysical Year (commonly known as IGY). The general reader is fed with scraps of information from the daily and weekly press, while the specialist is busy with his observations armed with all the sources of technical information that he may need in his particular field. Occasionally, the layman, scientist or engineer, who is not directly concerned with IGY but would like to know more about it, can find some of the details explained simply and accurately.

An excellent example of a brief, but authoritative, review of the work involved in IGY is a booklet "The International Geophysical Year" published for the Science Museum, in London, by Her Majesty's Stationery Office (S.O. Code 20-1087*). The booklet was intended for use with a special exhibition held at the Museum during IGY, but also as a lasting record of the work involved.

More than forty nations are taking part in IGY at a cost of over $250 million; the 'year' extending from July 1957 to December 1958. Simultaneous observations of phenoma throughout the world are being made from permanent installations and from many temporary stations, especially in areas not adequately covered by previous observations. The results should present the most unified picture ever obtained of man's physical environment.

The value of simultaneous meteorological, magnetic, and auroral observations in the polar regions was recognized by the First International Polar Year of 1882-3. With extended scope and advanced techniques, the Second International Polar Year took place fifty years later in 1932-3. The intention was to hold a similar international project in another fifty years, but in 1950 Dr. L. V. Berkner (U.S.A.) suggested that the advance of knowledge in these fields warranted a reduction of the interval to twenty-five years. From this suggestion, furthered by the International Council of Scientific Unions, the present IGY project developed — the period 1957-1958 being considered particularly appropriate in view of the expected sunspot maximum.

The programme of work during the 'year' was divided into sections such as meteorology, solar activity, geomagnetism, cosmic rays. These sections are reviewed in the booklet under four chapter headings — the sun; the atmosphere; the oceans; the solid earth. The chapters describe briefly the phenomena involved and how they are to be observed.

The booklet is illustrated with diagrams and photographs that range from sunspots, through the assembly of the projected earth satellite, to operations (including penguins) at an Antarctic base.

DISCUSSION *(Continued from page 1474)*

column generally has a far larger reserve strength after the first signs of damage than a tied column. However, it has been found that comparatively little of this reserve strength can be utilized because of the danger of the shell, outside the spiral, peeling off and the considerable shortening of such a highly stressed column. For this reason only a twenty percent advantage is given to spirally reinforced columns. If we based our design on ultimate strength only and used the same safety factor for spirally reinforced columns and for tied columns, we should certainly get into trouble.

The author wishes to make it clear that he does not mean that we should neglect to take the ultimate strength into consideration. If there is a large reserve strength which will prevent a closely following total failure after the initial overstressing, a smaller safety factor may be in order in many cases. Since, however, the strength, durability and appearance of a structure depend on service conditions, the safety factor should refer particularly to those conditions and not on the more unusual ones of total failure.

The above considerations do not prevent an adjustment of allowable nominal stresses where such are in order as, for instance, under conditions of lateral confinement.

DESIGN AND OPERATING FEATURES OF THE CANADA-INDIA REACTOR

F. J. Bleackley, M.E.I.C.

The Engineering Journal, 1957, Aug., p.1099

I. N. MacKay, M.E.I.C.*

Mr. Bleackley's paper is a clear description of the re-design of a complicated but successful piece of engineering equipment. This can be a challenging type of assignment, and it will be apparent to those who are familiar with the original NRX reactor that Mr. Bleackley and his group have made the most of their opportunity.

In particular I am sure that the large vertical holes, shielded rooms, and other provisions for complete loops will be most useful in the development of fuel elements for power reactor. The emphasis on the broadening of dimensional tolerances is laudable. That there was considerable scope for this may be concluded from the fact that the drawing of the original master plate, which determines the spacing between the fuel rods, showed dimensions of up to 120 inches specified to five places of decimals, with a note at the bottom of the drawing, "No tolerance on dimensions".

Questions which come to mind are largely in the realm of requests for further details concerning the design. For instance, what are the details of the automatic dampers which close off the air conditioning system in case of an explosion within the steel pressure-tight shell? To make the shell really effective, these dampers would have to close against a pressure of 30 pounds per sq. in. in a second or perhaps less, and be virtually leak-proof to gas at this pressure. The diameter of their opening is presumably two or three feet. Other queries are, why are the holes in the upper thermal shields not made initially sufficiently large to pass damaged calandria tubes without resorting to boring out in place; why is downward flow of the fresh water coolant in the reactor used; how will the steel containment shell be pressure tested?

*Manager, Engineering, Civilian Atomic Power Department, Canadian General Electric Company Limited.

REFLECTED RIPPLES IN THE RIDEAU CANAL

(Abstracts)

The Engineering Journal, 1956, January, 36.

B. A. Wightman ‡

Mr. Disher's letter regarding the ripples on the Rideau Canal prompts me to communicate some of their more interesting aspects. Many a sultry August evening in Ottawa have I sought refuge on the banks of the Canal. The ripples caused by the sightseeing launches were reminescent of electromagnetic wave propagation in hollow metal pipes. Such propagation may be regarded as the multiple reflection of a plane wave. The pattern of the fields corresponds to that of one of the bow waves of the boat reflecting from the walls of the Canal.

However, a phenomenon more closely related to the water ripples is the propagation of sound waves from a source moving at supersonic velocity. In the photo, the ratio (reciprocal mach number) of the velocity of the boat to the velocity of propagation of the ripples is the sine of the angle which the ripples make with the direction of the boat's motion (mach angle).

‡ Electronics Research Laboratory, Stanford, Calif.

DISCUSSION

The Editor invites discussion of papers appearing in the *Journal*.

Readers may contribute to this section by sending appropriate comments to the *Journal* office.

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

A cool, dry month of August saw record activity on all phases of the project, with employment attaining a new peak of more than 21,000 on both sides of the river, probably an all-time peak for the life of the undertaking. All phases of the work were reported to be on or ahead of schedule.

Progress by Ontario Hydro

The month of August was dry and favourable for construction work. A total of 5,250 persons was employed on the project areas during the month.

At the Canadian half of the powerhouse, concrete placing operations advanced well through the month. A total of 725,000 cubic yards of concrete had been put into this principal structure. The concrete placing for ice sluices 1 and 2 on the north end of the power dam was completed.

Turbine pit liners had been installed as far as unit 11 and speedrings to unit 12. At the administration and erection bay building, all concrete placing was completed and the brick work for the exterior wall was more than half finished.

Weather aided work on the Cornwall dike during August. Placing and compacting of glacial till had been essentially completed for sections 2 and 3 of the dike with only the railway gap between these sections yet to fill. Section 1 of the dike as well as the Cornwall canal closure structure and the powerhouse section were well above original ground level. The total amount of glacial till placed and compacted on the dike by the end of August had reached 4,300,000 cubic yards of the estimated 5,100,000 cubic yards.

With release of the old C.N.R. right-of-way last month, it became possible to close two gaps in Cornwall dike in August, following the lifting of the rails, and a start was made on the west half of the No. 2 highway relocation which will use the former railway right-of-way.

All contractors had begun grading work following removal of rails, and telegraph lines on the west half of the old right-of-way.

Excavation of the channel through Galop Island had been completed and flooding of this channel was scheduled for month end. With this flooding, draglines and dredges will remove the cofferdams.

At Iroquois Point, most of the excavation within the cofferdam had been completed. The building of the dike to join Iroquois control dam and the seaway canal lock well was essentially completed. At Point Three Points, the perimeter dike had been completed. About 300,000 cubic yards of material had been excavated and removed from this area.

All house moving into the new town of Long Sault was completed during August. Paving operations were in full progress, with work concentrated on streets and the parking lot area for the new shopping centre, and around the C.N.R. station. All this was completed by month end.

On the house moving program for Ingleside, 106 houses had been moved from Osnabruck township. In Ingleside, work was well advanced on three churches and work had started on the fourth church. The elementary school was practically completed, and the separate school 50 per cent completed.

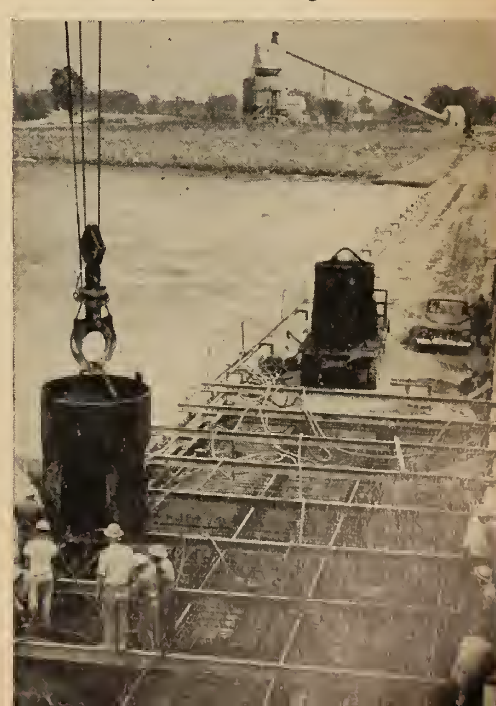
At Morrisburg, the masonry work for the shopping centre had been completed and roofing was 80 per cent finished. Work was progressing on the 60-unit multiple housing. In Iroquois, general cleanup continued with special attention to the park area. The first units of the rental housing were ready for occupancy.

Progress by NYSPA

August was highlighted by the completion of concrete operations at Iroquois dam, marking the near completion of one of the major features of the power project. Concrete placement for all project structures at month's end exceeded 1,590,000 cubic yards or 77 percent of the total requirement. Excavation exceeded 45 million cubic yards. Employment averaged 6,630 for the month.

Concrete placement at the New York half of the international powerhouse continued on schedule, and 65,000 cubic yards were placed, bringing the total to date to 766,000 cubic yards, or 79 per cent of the required total. Erection of structural

Iroquois dam. Final concrete was placed in the roadway section in August.



Long Sault dam. The stage 2 portion of the structure.

steel in the 115-kv. switchyard and concrete placement in ice sluices 5 and 6 had been completed.

At Long Sault dam, 81,000 cubic yards were placed during the month, bringing the total to date to 442,000 cubic yards. Rock excavation for stage 2 spillway apron was completed.

Concrete operations for stage 2 construction at Massena intake continued concurrently with backfilling of the upstream and downstream sides of the structure. Concrete placed to month end totalled 192,000 cubic yards or 99 per cent of the required total.

Channel improvement work at Sparrowhawk Point, Toussaints Island, Point Three Points, Leishman's Point and at Ogden Island was continuing. The channel work was approximately 84 per cent completed.

Construction of the relocated state highway route 37 was nearly completed and 1½ miles at the west end of the relocation were opened to traffic. With placement of the first six-inch stone layer on the subgrade completed, surfacing was in progress on highway route 37B, and on the bridges on state highway route 345 and Franklin Road in Waddington.

Excavation of the Massena beach area was completed except for fine grading. All suitable material from the beach excavation had been hauled and placed in the Richards Landing dike.

A contract was awarded for the construction of sewerage and water supply facilities in Waddington and another for reforestation work in construction and state park areas. Specifications were issued to bidders for construction of the substations at Plattsburgh and Kents Falls and also for the 115-kv. transmission lines for Reynolds power supply.

Progress by SLSA

At the upper Beauharnois lock, half the common excavation was completed and almost two thirds of the rock excavated. Some 32,000 cubic yards of concrete were placed in the upper gate section to enable a start on the railway bridge over the lock.

On the lower Beauharnois lock 75 per cent of the rock had been excavated 124,000 cubic yards or 48 per cent of the concrete had been placed; most of it in the lock chamber, with one wall poured to full height throughout. Work continued on the highway tunnel with one double traffic lane in service.

At Cote Ste. Catherine, with 2 million yards of earth and 1,430,000 yards of rock removed, 247 cubic yards or 65 per cent of the concrete was placed, mostly in the lock structure. No installation of machinery had taken place. Though reported 'on schedule', work may be continued during part of the winter.

The St. Lambert lock will be the last of the five Canadian locks to be completed. In a drive to enable installation of machinery to commence in October, efforts were under way to complete placing of concrete in the lock structure during September. The downstream approach wall was completed and the upper approach wall started. The south shore collector sewer between the channel and St. Lambert was practically completed. Work on this lock will continue during the winter.

Iroquois Lock Open in November

The last mass concrete pour was placed at the Iroquois lock on August 28, 1957, marking completion of the first major structure on the seaway. The lock will provide access between the power pool in the International Rapids section and the stretch of river leading through the Thousand Islands to Lake Ontario. SLSA engineers look forward to the possibility of passing ships through this lock before the end of November.

Dredging of the approaches upstream and downstream of the lock is proceeding under contract. The upper approach area to the lock proper was flooded in September. Cofferdams were being removed and gates and feeders were receiving a long series of tests.

The two sets of sector gates at the upper end of the lock were already installed. The lower two sets of sector gates were to be installed by October 15 and the testing program completed by early November.

The International Rapids section will be flooded by mid-summer next year, and the Cornwall, Morrisburg, Farran Point and Galop canals will be unusable. Consequently ships, although still proceeding at the present canal draught of 14 feet, will require to use the Iroquois lock for entry into the power pool from upstream and the two United States locks to leave it and continue on to Montreal via the Soulanges and Lachine canals for 1958 only.

Jacques Cartier Bridge

At end of August the new through span had been erected on the upstream side on falsework. It will be slid into place as the old deck-span is removed in October. Through the lifting stages the various spans will then be raised 6 inches at a time and at intervals of two feet concrete courses will be poured till necessary elevations are obtained. Fin al position will give 120 ft. clearance between roadway and waterlevel in the canal with downgrade 1,000 ft. northward to pier 14 and southward 1,400 ft. to pier zero at south shore.

A new target date, — mid October, had been set for completion of the bridge-raising project's second phase, in place of November 2 as originally planned.

Bridges

The Dominion Bridge Company, contractor for the steel superstructures on all four existing bridges at Montreal over the seaway, was also assembling equipment at end of August for erection of steel on the two railway bridges, Victoria and Caughnawaga.

On a contract awarded last June by the federal Department of Transport, the contractor had built 4 piers for the Nuns' Island highway bridge. These piers, located within the area to be flooded by the seaway channel at the south end of the bridge, were started ahead of the others to enable them to be built 'in the dry'.

Mercier Bridge Piers

Forty-five new piers to support the new high-level approach to the Honoré Mercier bridge between the Island of Montreal and the south shore of the St. Lawrence, are being built by a modern type of concrete construction, known as the "slipform method".

The basic principle behind this operation is to place concrete in the form while it is being continually moved. The lifting is performed by means of hydraulic jacks which are supported and "climb up" one-inch steel rods which extend down into the concrete.

At the start of each pier, jack-supporting rods and forms are carefully set on the footing. The four to six foot deep form is then filled in layers of about eight inches. As soon as this concrete has set sufficiently, the jacking operation is started, slipping the form up at the rate of 10 to 20 inches per hour depending on the rate of placing and setting.

The placing of concrete is carried on continuously, 24 hours a day, and piers up to 100 feet high can be completed in a five-day week. The whole of the work, consisting of 30 single piers, 15 multiple piers, and two abutments, ranging in height from 50 to 110 feet and containing 25,000 cubic yards, when completed by October will have been erected in five months.

Progress by SLSDC

By the end of August, only 2 million cubic yards or 13 per cent of the excavation remained to complete on the mainland section of the Long Sault canal, all of it dry excavation.

Placing of concrete was completed for both the Eisenhower and Grasse River locks, and installation of lock gates and operating mechanism had begun. Other operations such as dikes, clearing, etc., were on schedule. Employment during August varied between 2000 and 1500.

Seaway News

Ease Traffic at Montreal Port

A $2 million 'suburban' Montreal harbour will open at Côte Ste. Catherine with the seaway. This was announced early in August by Transport Minister George Hees. Main object of the new wharfage is to help facilitate the trans-shipment of cargoes from downbound lakers, thus easing the crowding in Montreal harbour itself. Four thousand feet of new wharves are to be built above the Côte Ste. Catherine lock, just below Mercier bridge. Tenders are to be built above the Côte Ste. Catherine lock, just below Mercier bridge. Tenders are to be called within a few weeks. Administration will be under the Seaway Authority for the present though the National Harbours Board might take over later. Railway sidings are already laid at the site.

Water Routes to New York and Ottawa

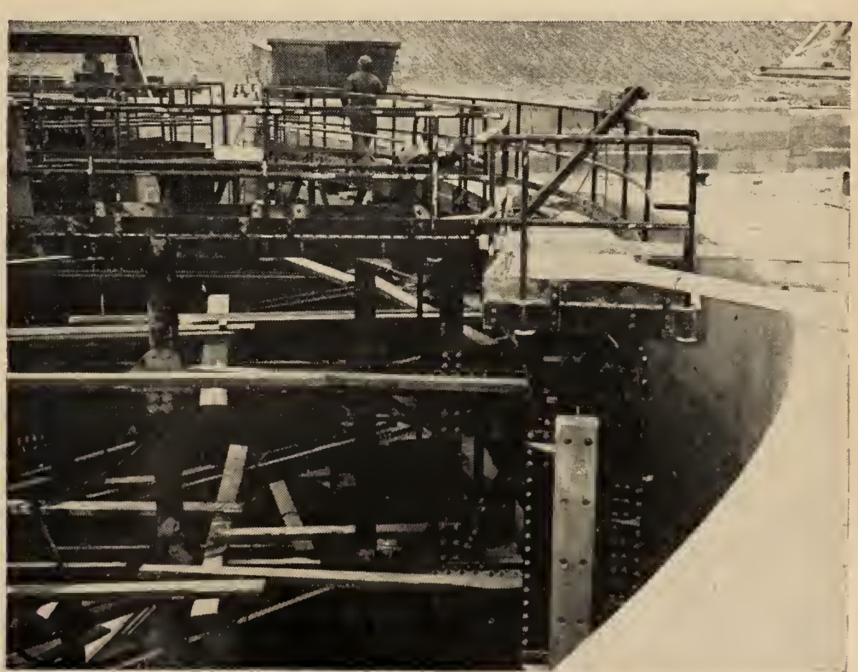
New efforts were under way in August by Chambre de Commerce organizations of the south shore to press for an inland waterway between New York City and Montreal. The Federal Government will be asked to study the project. A measure introduced by Congressmen Aiken and Prouty in the U.S. Congress recently would authorize American Army Engineers to survey the route from Albany to Lake Champlain and thence to Sorel.

The Ottawa Valley Development Board was formed late in July to revive Ottawa valley shipping over a 'secondary seaway'. Tupper Porter, technical adviser to St. Andrews East Chamber of Commerce, told the conference that "for a mere $30 million the Valley could buy an entirely new economic era". Ultimate goal would be a canal system to Georgian Bay, a dream dating back fifty years.

British Seek "Order of Principle"

Viscount Simon, president of the British Chamber of Shipping, called recently for a further statement of

Mitre gates under construction at Iroquois lock.



principle that there would be no discrimination in the use of the seaway. He called for a toll structure that would be simple in operation and at a rate attractive to traffic. The practical application of these principles, he emphasized, was of vital concern to British shipping.

Battle on Tolls

A showdown fight on seaway tolls is shaping up. SLSDC called a tolls conference for September 9. SLSA called a tolls conference in Ottawa for September 19 with a view to determining a toll rate low enough to attract traffic yet high enough to provide revenues to pay the cost of the seaway. Potential users have been invited to attend and to express views on toll assessment methods and practical means for payment. Jean Claude Lessard, SLSA vice - president, replaces Charles Gavsie as president of the Canadian Tolls Committee.

Another conference was to convene at Chicago on September 11, called by anti-seaway groups who have formed a national organization to fight N. R. Danielian, chairman of the U.S. User's Committee on Tolls, and his arguments for lower initial toll rates and an extended pay-back period. This group is called 'the national committee for a non - subsidized seaway' with Congressman George Fallon of Maryland as chairman.

Fallon stated midwestern business interests will urge that 'bargain rate' tolls be set by SLSDC. There are plans under foot, he warned, to ask Congress next year to amend the act to permit repayment over a 100 year period. This, he said, would amount to a subsidy.

While this committee's views and those of SLSDC Administrator Castle and the U.S. Tolls Committee favour paying off seaway debt in fifty years, Danielian argues the choice is between low tolls and a big movement of vessels through the seaway, or high tolls and a small movement of vessels. He believes the cash gained in tolls would be about the same either way, but prefers the low toll and big movement approach.

October Coal Parley

Effects of the seaway on coal marketing in North America was discussed on October 10 at Quebec. Sponsoring the meeting were the American Institute of Mining, Metallurgical and Petroleum Engineers, the ASME and the C.I.M.M. Several hundred delegates attended. A film entitled 'The Eighth Sea', a documentary on the Seaway, was shown. 'Coal, a source of Canadian Energy', was outlined by C. L. O'Brian, chairman of the Dominion Coal Board. John R. Frith of Cleveland, discussed 'the influence of the seaway on coal marketing'.

Amortization Period Unimportant

H. M. Paint, in a recent article published in 'the Canadian Banker', points out that the seaway is an inland waterway and will always remain so. Every journey a deep sea freighter makes to Lakehead means fewer ocean crossings for the owner. They are unlikely to travel the seaway unless assured of a profitable return trip and reduced tolls for returning in ballast . . . The seaway, he warns, must be regarded as simply an alternative shipping route with certain advantages if tolls are not prohibitive.

The author warns Canadian shipping won't have an easy time of it. There will be intense competition, particularly since U.S. legislation exists designed to help the shipper. "Only madness would prevent the Seaway Authority from setting tolls which would largely increase traffic", he argues . . . . "When the fact is remembered that the seaway will be a permanent continental asset, it becomes relatively unimportant whether the cost is spread over 25, 50 or 75 years".

Black Lake Asbestos

An asbestos mine and mill at Black Lake, Quebec, will produce about 100,000 tons of asbestos fibre a year, which will be approximately a 10 per cent addition to Canada's production. First mining is expected to be done in mid-1958.

The agency responsible for the $32.5 million development is Lake Asbestos of Quebec, Ltd., a wholly owned Canadian subsidiary of American Smelting and Refining Company, New York.

United Asbestos Corporation Ltd., a Canadian firm, did the early location and exploration under Black Lake, but entrusted the financing, development and operation to American Smelting, on a long-term profit sharing agreement.

The submarine mining aspect is of special interest — involving the removal of 37 million cu. yd. of overburden, control of drainage of Black Lake, a key part of the drainage system of a populated area, and provision for flood control to replace the regulating effect of the lake.

Black Lake and the town of the same name, are some 5 miles from the town of Thetford Mines.

Open pit mining was selected and preparations made for the hydraulic engineering necessary for the project. Since the lake was eventually to be drained, the Becancour River had to be diverted. This was accomplished by digging a new river channel, 8,000 ft. long, which by-passes the lake across the north side. The new channel was designed to take care of flood stages of the Becancour upstream. A control dam was built below the diversion channel, and another six miles further downstream. In this way a new flood plain area was formed to compensate for the regulating effect of Black Lake which had been removed from the water circuit. Drainage into the new channel was provided by a system of diversion and drainage ditches.

An integral part of the hydraulic system is the disposal of waste, including that from the dredging operations. Methods have been devised for the deposit of silt as it is pumped out, and for the return of water to the lake to maintain a water level satisfactory for dredging at any stage.

A highway diversion was necessary, and a spur from the Quebec Central Railroad was brought into the property.

A 200-ton dredge, specially constructed, and powered electrically has a 75-ft. cutter and suction ladder. The cutter, fitted over the suction end of the pipeline, dislodge the material so that it can be removed hydraulically.

The dredge in one position can swing about 250 ft., cutting a bank 250 ft. by 30 ft. by 8 ft., in 4[illegible] minutes or an hour. The average rate of removal is one million cu. yds. per month.

Although dredging will continue until early 1959, the lake should be low enough in mid-1958 to allow initial mining operations and tune-up operations in the mill. Open pit mining should be possible for about 20 years; after that underground methods will probably be necessary. Ore reserves are estimated at 47 million tons, and the mill will have a capacity of 5,000 tons of ore per day.

The mill, although not boasting unique features, will have modern production equipment and quality control facilities. It will produce all grades of asbestos from the longest to the shortest fibres.

Ottawa University Extends Engineering

A newcomer to the field of institutions of learning which operate a complete course in electrical engineering leading to the degree of bachelor of applied science is the University of Ottawa. The current calendar shows that the fourth year of the electrical engineering course will be offered in the coming academic year, and the fifth year in 1958-59 for the first time.

The university has been giving the first three years of the course for several years. Since 1954 it has had a complete five-year course in chemical engineering.

A School of Applied Science was founded at Ottawa in 1946, resuming teaching of engineering discontinued many years before. Earlier than 1880 civil engineering was being taught there, and mechanical and mining engineering from 1885, these activities being curtailed by a disastrous fire in 1903. In 1953 the Faculty of Pure and Applied Science was decided upon.

There is a new electrical engineering building; a chemistry building and auditorium are under construction. Progress has been rapid in equipping the new electrical engineering building and assembling a staff sufficient for the needs of the expanded course. The building is designed with a view to graduating 15 to 20 electrical engineers per annum and is being equipped gradually for that output. At the same time facilities are being developed for the support of a research program.

Every effort is being made to form a quite modern kind of undergraduate course, without rejecting many well-proven traditional features. To this end, the University is on the lookout for men with advanced ideas as well as advanced degrees to assist in this development.

Ontario Hydro News

Ontario Hydro announced major plans late in August and early September for additional plants affecting the southern Ontario system, the northwestern and northeastern systems.

Southern Ontario

Sites at Long Branch and Burlington are being considered for two thermal-electric stations that will be among the largest in the world. They will be part of the southern Ontario system, their locations chosen in relation to the fast-growing Lake Ontario industrial area.

The first of these stations, representing a capital investment of $250 million, will have 1,800,000 kilowatts capacity, more than double that of the Commission's St. Lawrence power project. The second will be of comparable size. The Commission expressed hope preliminary work on both stations would be started before the end of this year. The timing is not fully determined, but both will have been completed by 1968, according to present plans.

The turbo-generators to be installed at the first plant are expected to be of 300,000-kw capacity, and tenders have already been called for two units.

Areas were sought providing 150 acres of space for plant, dockage facilities for some 5 million tons of coal per year, cooling water, and suitable foundation conditions and right of way for transmission of power into the system. The Long Branch site, familiarly known as the Rifle Ranges, owned by the Department of National Defence, and the prospective site at Hamilton owned by the Hamilton Harbour Commission, which will be reclaimed by suction dredging, meet the necessary requirements.

Why Not Nuclear Power?

In reply to the question why, having exhausted major hydraulic power sources in southern Ontario, it does not turn to the use of native uranium rather than imported coal, the Commission issued a statement.

"No one can state with positive assurance just when energy produced by nuclear plants could be available at a cost competitive with thermal plants", the Commission stated. "Meanwhile, the Commission has a very clear duty to perform in insuring that power is available when required to meet the fast growing demands of industry and the public, and also to see that this power is available at the lowest cost consistent with satisfactory service."

In a second statement the Commission explained further: "By 1961-62 the demand for power in Ontario will be greater than we can supply with our present resources, and nuclear plant development has not yet reached the stage in Canada, or in any other country, where this source of power would be in any way competitive in cost with coal."

To those who point to Britain's Calder Hall and consequent developments as a guide for the Commission, it was explained: "The facts are that the cost and growing scarcity of coal on the one side, the hazards surrounding the importation of oil, and the much lower labour rates in England result in conditions which favour nuclear power in that country on a basis which would be entirely uneconomical in Canada or the United States." Further, "If it were possible to build a British type gas-cooled, graphite-moderated reactor plant in Canada in 1961, the energy derived from it would be at least twice the cost of that obtainable from a base load coal-fired plant, and the improved versions of such plants, according to Sir Christopher Hinton's figures, would not appear to be economically competitive in Canada before 1977."

Meanwhile Ontario Hydro and colleagues are pursuing at Chalk River an anticipated solution, (based on a heavy water moderated reactor) with the hope of practicable and economical application before 1970.

Fort William-Port Arthur

Ontario Hydro will begin construction immediately on a thermal-electric generating station at Fort William, on Island No. 2, fronting on Lake Superior beside the Mission River.

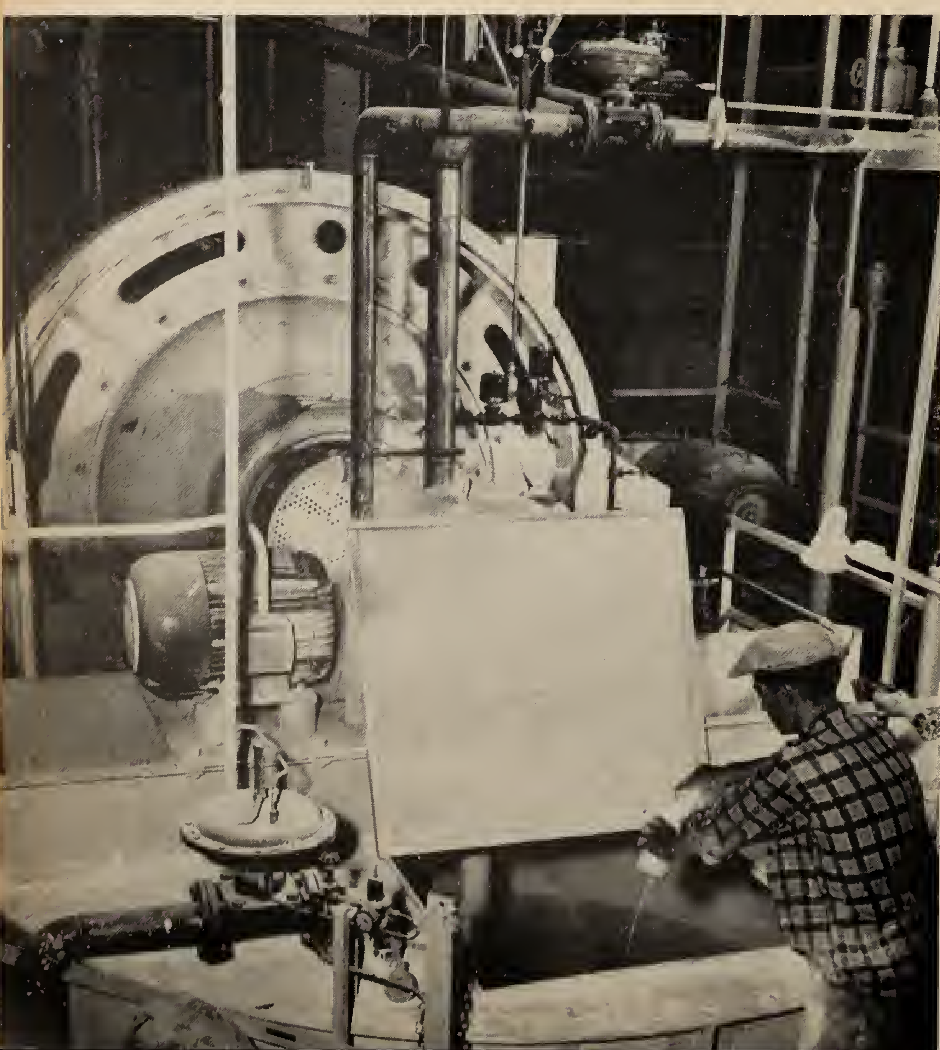
Scheduled for service in 1961, the new plant will supply power to the northwestern network; it will have an initial capacity of 100,000 kw., with provision for enlargement to 1,000,000 kw., the initial cost, $26 million.

The plant is said to be essential to meet increasing power demands and to support present sources. In this area, the Commission has six separate projects actively under construction, with a combined capacity of 209,000 kw., to bring the resources in the division to 579,300 kw. by 1959.

Abitibi Plant

A 45,000-kw., 60-cycle generator is to be installed at the Abitibi River at an overall cost of $3 million. This is meant to give improved service security in the interconnected southern and northeastern systems.

Titanium Pigments. The first Canadian plant designed to produce titanium pigments commenced production in September at Varennes, Quebec, built by Canadian Titanium Pigments Limited. The basic raw material, titanium slag, comes from Sorel, 40 miles downriver on the St. Lawrence. Chemical processing equipment will allow round-the-clock operation.



Canadian Pipeline Projects

Westcoast Transmission

Final weld on Westcoast's main line was made on August 8 at mile 119.5, close to the geographic centre of British Columbia. This terminated the vast construction program which had employed some 2,200 men yearly for the past three years. Altogether some seven million tons of earth had been moved and more than 230,000 tons of pipe placed in the ground. In addition, 154 miles of gathering lines ranging from 8 inches to 26 inches in diameter were still being laid.

Testing of the line was being completed late in August and clearing and purging operations were under way. Dry, clean Alberta gas was flowing into the line at the north end of the pipeline, while at the south end imported gas was flowing northward from the Pacific Northwest system. North and south gas was expected to meet at compressor station 5, 20 miles south of Quesnel, by early September.

The only really difficult terrain had been in the Boston Bar Pass through the coast range, where the pass elevation was 4,510 feet. In large part, the route parallels the Transmountain Oil Pipeline and the Canadian Pacific Railway, until it emerges into the Fraser River valley to terminate at the U.S. border. There were eight major rivers to cross, two with underwater crossings and six with aerial crossings. Pipe was buried to a minimum cover of 36 inches. Initially four compressor stations were installed, aggregating 52,500 hp. With these the pipeline will have a sales delivery capacity of 400 million feet daily. By installing four intermediate stations to bring installed horsepower to 189,000 hp., throughput can be raised to 660 million cubic feet daily.

In the first formal step towards greatly boosting export of Alberta gas into Pacific states, Westcoast announced in mid-August it had made application to the Alberta Conservation Board for permission to export 155 million cubic feet daily from the southwest corner of Alberta through a 175-mile pipeline through the Crow's Nest Pass. The pipeline, 20 inches diameter as far as Coleman and 30 inches to the border, would draw from several Alberta fields with total indicated reserves of several trillion feet. Bulk of the gas has been contracted for by Pacific Northwest Pipeline Corp.

Westcoast reported at the same time it had completed signing of contracts for 100 per cent of the gas reserves owned by present participants in the Savanna Creek field, and in addition had completed contracts for a major part of the indicated reserves in the East Calgary gas field. Prices to be paid are the best so far publicly announced for any gas so far signed up for export. Savanna Creek 'wet gas' will be picked up by Westcoast at wellhead and piped to a proposed processing plant in the Crow's Nest Pass. Suppliers will receive 12 cents per thousand feet, increasing to 13 1/3 cents the fifth year, and then escalate 1/3 cent yearly.

Contracts involving East Calgary gas were completed with Jefferson Lake Sulphur Co. and Merrill Petroleums. Jefferson is developing an 80,000 acre project immediately east of Calgary's city limits. Sufficient reserves will be proved up to support a 300 ton per day sulphur processing plant. Reported price of 14 cents per thousand feet for field-gathered gas is the best so far announced publicly, and will be boosted to 15 cents the third year, with subsequent escalation of ¼ cent yearly. Initially these contracts call for the supply of 50 million cubic feet daily with peak of 125 million feet.

Inland Natural Gas

Pipelaying had been 87 per cent completed by late August on the 10-inch and 12-inch sections and was well advanced on the 8-inch and 6-inch portions of Inland's large gas main pipeline through the interior of B.C. Final completion was expected by the end of September. Testing was completed on 120 miles and clean-up done on more than 200 miles. Toughest portion of the project had been the 10-inch portion between Penticton and Rossland, over the Cascade range.

City and town distribution systems had been completed by end of August in Penticton, Kelowna, and Summerland, and were complete except for installing services at Vernon, Kamloops, Merritt, 100-Mile House, Williams Lake, Quesnel, Grand Forks and Castlegar. Distribution systems at Trail and Rossland were well under way. About 90 per cent of the entire distribution systems was complete, with installation of 24 city gate stations in progress. Gas will be available at Savona early in September for cleaning the system prior to arrival of Peace River gas.

Alberta Gas Trunk Line

Fulton Bannister, Ltd. had completed 17 miles of 34-inch pipeline by late August and was proceeding with construction of 100 miles of 18 inch pipe from the Provost field to Burstall. Work was also progressing on 29 miles of the gathering system at the Provost field. AGTL, at the request of Westcoast Transmission had been carrying out surveys to determine the cost of pipeline construction from a point northeast of Calgary to the British Columbia border in the Crow's Nest Pass, and costs of a 30-inch line from Westcoast's proposed gas plant in the Coleman district to the B.C. border.

Approval of the Alberta and Southern Gas Co. Ltd. proposal for a 1,300-mile pipeline to San Francisco would call for a second major gathering line by the Alberta Gas Trunk Line system, more than doubling the present facilities now under construction. A 500-mile gathering line is envisaged from the B.C.-Alberta border near Fort St. John, through Pembina, Sundre, East Calgary fields and possibly the south half of Pincher Creek field and via the Crow's Nest Pass to California.

Winnipeg Central Gas Co.

Winnipeg's long awaited natural gas rates were set September 3 by the Municipal and Public Utility Board. Rates are higher than those proposed for other nearby Manitoba communities but somewhat below those proposed by the gas company, and will cut 10 per cent from its estimated 1958 gross revenue.

Conversion to natural gas is expected to be completed by mid-November. The company expects to have some 4000 new residential customers by year-end. Almost all the present 15,000 customers are industrial or commercial. By fifth year of operation, demand is expected to increase to 47/50 million cubic feet daily.

Trans-Canada Pipelines

By late August, Dutton Williams Ltd. had completed section 4 of the 34-inch pipeline from Alberta to Winnipeg. This was the last contract to be completed. Sections 5 and 6 had been completed by Price-Poole and Canadian Bechtel about mid-August. Testing had been commenced and the entire line was expected to be ready for operation as far as Winnipeg by early September.

Dry weather in August speeded up the work on the stretch between Winnipeg and the Manitoba-Ontario boundary. Weather is not expected to be a serious factor on this section due to the fact that trenching through the muskeg areas is completed and the right of way beyond

Plastic Cables. Phillips Electrical Company Limited, Brockville, Ont., officially opened a plant at Vancouver recently to produce all-plastic insulated wire and cable, the first such plant in Canada. The modern equipment includes the huge cabling machine shown in the accompanying picture, which can handle 12 units at once.

the present end is solid rock.

It is becoming apparent that some of the work on the Crown Pipeline will be suspended over the winter before reaching Lakehead. One major bottleneck is the crossing of the Winnipeg river at Kenora. Rock drilling here will not be completed before December. Pipelaying was to start September 1. Some pipe was delivered in August and stringing was proceeding, but only 15 miles of ditch was done at the end of August.

Of the three other contractors on the Crown Pipeline only one will finish by late fall. The completion date to Lakehead is now of small consequence however, since the heating season has already started and conversions to natural gas are not feasible during cold weather.

Work on the Toronto-Montreal stretch of the Trans-Canada line was progressing rapidly in August in various places thoughout its length. Dredging the lake bottom for the crossing of the Lake of Two Mountains to the Island of Montreal was under way.

On the Oklahoma Constructors' spread in the Oshawa area, 19 miles were welded at the end of August out of a total of 84 miles. Dutton Williams Bros. in the Newcastle area had 50 miles cleared and 20 miles graded on their 114-mile section. In the Cornwall section, Grayco Constructors had 45 miles welded and a further 94 miles to complete.

Project to Reduce Flares and Waste

Alberta's Conservation Board late in July approved in principle a $17 million scheme to utilize gas now flared and wasted from the Pembina oilfield.Accepted plan was submitted by Goliad Ltd., Canadian subsidiary of W. H. Bass & Sons Inc. of Oklahoma City. Imperial, Texaco, B.A. Oil, Tennessee Gas Transmission and Canadian Superior Oil of Calif. Ltd. were in agreement with the plan, though not ready to sign the existing agreement. L. C. Stevens, chairman of the Pembina Operators Committee, stated 25 million cubic feet daily may be available from the field, and that Trans-Canada has offered to take this flow for a 15 year period. Negotiations are also under way with Pacific Gas and Electric Co. and local utilities for export to California.

Lakeland Natural Gas of Kingston has obtained a franchise from the Ontario Fuel Board to supply Ganonoque, 17 miles east of Kingston, with natural gas. This is the company's nineteenth franchise obtained from Port Hope to Cornwall. Lakeland is still competing with Consumers' Gas of Toronto for the franchise to supply the city of Kingston. Construction of the local systems will be commenced early in September.

Northern Ontario Natural Gas plans to 'sell' its natural gas from Trans-Canada throughout its far flung region by setting up free-of-charge information centres in key communities, and by conducting educational functions prior to the delivery of gas. President R. K. Farris will set up an industrial research division as an active clearing house to assist in coordinating research, development and industrial location functions, between finance, industry, development associations, boards of trade and other civic groups.

The company has awarded contracts for distribution networks at Fort William, Port Arthur to Campion Pipeline Services, and at Kenora and Dryden to Manitario Gas Systems Ltd.

Pipeline News

Formation of a company to pipe Alberta gas 1,300 miles to the San Francisco area was announced August 27. Alberta and Southern Gas Company, Ltd., proposes to spend $330 million for a pipeline with initial daily capacity of 400 million cubic feet and plans initial operation late in 1960. Construction will start as soon as government approvals are given by Alberta, Ottawa and Washington.

This is the project announced jointly last July by Canadian Bechtel Ltd., and Pacific Gas and Electric Co. of San Francisco. The line will follow a route west from Calgary, through the Crow's Nest Pass and through the Pacific Northwestern States. J. B. Black of San Francisco, Board Chairman of Pacific Gas and Electric, was elected chairman of the Board and S. M. Blair of Toronto vice-chairman. J. K. Horton of San Francisco was named president and chief executive officer.

Gas Prices

Federal government review of all export and import permits for gas may result from the announcement by Pacific Northwest Pipeline Corp. that it wants to charge 17 per cent more to its wholesale customers. This would include Canadians, and the company expects to earn an extra $105,000 yearly by increasing its prices in Canada. Pacific Northwest is supplying gas to Vancouver only until Westcoast's gas arrives there this fall. But it has a 20 year contract to supply Trail, B.C. The 22 cents the company pays Westcoast for Canadian gas at the border is less than is paid by Westcoast's B.C. customers. Stiffening of federal control across the border is regarded as inevitable.

Valve assembly is being welded to the 34-inch main line on this section of the Trans-Canada Pipe line from Alberta to Eastern Canada.

Canadian Arctic Studies

Tidal Research

Two unique Arctic tidal stations form a part of Canada's contribution to the International Geophysical Year ocean studies. The instruments arrived in the Arctic in August to enable Canadian researchers, already advanced with preparations, to install stations at Resolute, on Cornwallis Island, and at Brevoort, off the southeast tip of Baffin Island, which will reach beneath the heavy ice crust to record ocean movements.

At Resolute, over 2000 miles north of Montreal, tidal gauge instruments were installed at the end of a specially built rock and gravel causeway.

Readings were already being taken from instruments at Brevoort Island, where Department of Mines and Technical Surveys men had installed a special instrument developed for the Arctic probe by National Research Council.

Located on a tripod on the ocean floor, a pressure cell transmits changes of the ocean level back to land by means of electrical impulses carried over specially designed cable.

Readings will continue to flow into the tidal stations, during the Arctic winter, from the instruments then inaccessible under thick ice. Rotating graphs will record the ocean movements. As a precautionary measure, each Arctic survey post will have three gauges.

These Canadian posts are linked with I.G.Y. hydrographic studies at five other permanent tidal stations located at Churchill, Man., Halifax, N.S., St. John's, Newfoundland, and at Tofino and Prince Rupert in British Columbia. The Canadian findings will be of use to the Department in studies for navigation and engineering projects in the Far North.

Air Photo Mapping Study

1963 is the date set by the Dominion Government for completion of a fully effective photographic coverage of the Canadian Arctic Archipelago.

The six-year project is planned to cover 500,000 square miles and to cost $6.3 million. Participating in the work will be three aerial survey companies: Aero Surveys Ltd., of Vancouver, Photographic Survey Corporation of Toronto, and Spartan Air Services Ltd., of Ottawa, all experienced in vertical photography, and having the equipment essential for this largest operation of its kind ever undertaken in the free wold.

Each company has been assigned one of three major sections of the area to be covered. Thousands of pictures, taken by large cameras at a height of 30,000 feet and resulting in photographs on the scale of approximately one mile to the inch, will be used for precise mapping to aid resources development and to amplify defence information. This photography combined with the recently completed R.C.A.F. Shoran operation, will furnish the main basis for detailed mapping of the Canadian Arctic Archipelago.

Arranged by the Department of Mines and Technical Surveys, the program will help other interested departments also, whose requirements were added to the over-all plans. All photographs resulting from this coverage will be made available to other departments, and to the public through the facilities of the National Air Photo Library at Ottawa.

Frequency Standardization in Cape Breton

An extensive program of frequency conversion from 25 to 60-cycle power has been completed in Nova Scotia. Initiated by Dominion Steel and Coal Corporation and its subsidiary, the Seaboard Power Corporation Limited, the program involved conversion of the Dominion Coal Company's operations in Glace Bay and New Waterford, as well as the residential, commercial and industrial facilities and service in New Waterford, Dominion and environs.

A co-operating public, four power retailing companies, the municipal corporations of three incorporated towns, the County of Cape Breton, two electrical service companies, Cape Breton's biggest industry and the power producing Seaboard Power Corporation Limited, made possible ease and efficiency of the conversion so that the program almost escaped notice elsewhere.

Costing hundreds of thousands of dollars to the industry, the plan was effected to cause minimum inconvenience to the consumer. It was first launched in 1929, and eventually delayed by a depression and by World War II. Pioneer promoter of the plan was E. L. Martheleur, chief electrical engineer of Dosco. As a result, Cape Breton's power-producing facilities are now concentrated for greater efficiency.

Dosco pioneered the use of pulverized coal in specially-constructed steam boilers for development of electricity. The Seaboard Power Corporation of Glace Bay now has an installed generating capacity of 70,000 kilowatts and operates with efficiency on pulverized fuel exclusively. The Seaboard system is tied in with the power generating plant of Dominion Iron & Steel Division, thereby giving Dosco a total available capacity of 105,000 kilowatts. The big plant uses some 150,000 tons of coal per year.

For the conversion to 60 cycles, the majority of the cost was borne by Seaboard, the balance being absorbed by the retailing agencies, Dominion Utilities Company, Limited and the Town of Dominion. Dominion Utilities, an independent company owned by The Eastern Light and Power Co. Ltd., replaced 2,800 25-cycle meters, erected new 60-cycle substations, and replaced all high tension transformers.

One direct advantage is easier interchange with No. 3 power plant at the Sydney steel plant and improved service. The new 60-cycle, 600-hp., 163 r.p.m. C.G.E. motor and rotor drives an Ingersoll-Rand compressor which pumps compressed air down the back deep at No. 16 colliery. The compressed air is used to power machinery and air driven pumps. Need of a frequency changer at the Waterford Lake Power plant is eliminated.

Canadian Developments Section is continued on Page 1620

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE
ELECTIONS AND TRANSFERS

Additional Assistant General Secretary

On September 1, Dr. Garnet T. Page joined the Headquarters staff of the Institute as an assistant general secretary. For many years he has been general manager and secretary of The Chemical Institute of Canada. For a considerable portion of that time he has been also managing director of the society's publications.

Though born in the Maritimes (Halifax) he was graduated from the University of Saskatchewan in 1940 with a B.A. degree in chemistry. He is the recipient of honorary degrees from several European universities, and medals and awards from various European countries. He has been decorated by His Majesty King Paul of Greece and Pope Pius XII.

Dr. Page has taken an interest in military affairs, training as a cadet in the C.O.T.C. at Saskatchewan. On active service in 1939-1940 he served as a lieutenant in the Saskatoon Light Infantry. He was seconded to the General Staff for work on chemical warfare and in 1942 was transferred to Intelligence. He retired in 1945 from a staff appointment in the Adjutant General's Branch. He is now a member of the Reserve of Officers with the permanent rank of captain, and an associate member of the Cameron Highlanders of Ottawa with the acting rank of lieutenant colonel.

He has published many papers, reports and pamphlets on a wide variety of subjects including United Nations and UNESCO affairs, chemical warfare, the chemical industry and education for engineering and science economics. He was appointed by the Cabinet to represent Canada at four sessions of the General Conference of UNESCO. Also he wrote and delivered forty-nine broadcasts on popular science for UNESCO. These were broadcast from European and South American centres to over fifty countries.

Dr. Page has rendered a great number of services to the Federal Government through many departments. The ministries and agencies for which he served on committees or acted as consultant are Departments of External Affairs, Labour, National Defence, National Health and Welfare, Trade and Commerce, Post Office, Bureau of Statistics, Civil Defence, Civil Service Commission, National Film Board, National Research Council, etc.

Dr. Page holds or has held office with many organizations such as chairman of committee on immigrant problems of Canadian Citizenship Council, co-founder of the scientific film division of the Canadian Film Association, honorary president of National Federation of Canadian University Students, secretary of the Canadian Committee on Counselling in Engineering and Science, and president of the Ottawa Branch of the University of Saskatchewan Alumni Association.

At the recent annual meeting of the Chemical Institute, the president, Dr. Clifford Purves of McGill, made a presentation to Dr. Page on behalf of The Chemical Institute of Canada. Perhaps a short quotation from the address delivered by Dr. Purves will give Engineering Institute members a "close-up" of the new assistant general secretary.

"The extensive knowledge that Dr. Page has accumulated about the professional social, educational, national and international aspects

Dr. Garnet T. Page, M.E.I.C.

of science and about administration procedure, has always been available on request. His unassuming courtesy, friendliness, and initiative have won for him the confidence of a great many people of diverse interests, and his unfailing willingness to help whenever he can has usually brought forth willing co-operation in return. These qualities have nourished the internal growth and development of the C.I.C. very effectively, and have much to do with the happy relationships the C.I.C. has always enjoyed with other professional, governmental and educational organizations. Although hundreds of members have devoted themselves to our progress, relatively few have occupied a position as central as that of General Manager, and none for so long a time. It is therefore safe to say that the C.I.C. as it

Cover Picture

The cover picture is an aerial view of the Iroquois lock of the St. Lawrence seaway. Recesses for the sector gates can be seen at either end of the lock.

Photograph by Spartan Air Services Limited exists today owes as much to Dr. Page as to any other individual. We can thus look back with warm appreciation on the eleven years of his life which Dr. Page has devoted so wholeheartedly to the interests of Canadian chemists and chemical engineers."

Wintertime Construction

Since March, 1955, the Engineering Institute of Canada has taken an active part in the work of the Joint Committee on Wintertime Construction. The Institute representative is W. B. Pennock, M.E.I.C., of Ottawa. Sponsored by the Canadian Construction Association, the Joint Committee includes representatives of the Canadian Chamber of Commerce, the Canadian Manufacturers Association, the Canadian Legion, the Canadian and Catholic Confederation of Labour the Canadian Labour Congress, the National House Builders Association, and the Royal Architectural Institute of Canada, as well as the Engineering Institute. Associated with the Joint Committee are the Federal Department of Labour, the Division of Building Research of the National Research Council and the National Employment Advisory Council.

In September, 1956, the Engineering Institute Council approved the following statement on wintertime construction for the use of the joint committee: Engineering projects are not shut down in winter when the cost of shut down, including the interest on funds invested, exceeds the extra cost involved in winter construction. While there are exceptions, the quality of construction work carried on in winter in Canada need not suffer providing planning, supervision and control of the work is done by qualified engineers."

During the past two winters, the Joint Committee has fostered national campaigns, with vigorous local support in many centres across Canada. These campaigns have been conducted to increase winter work and to keep materials moving during the usual cold weather seasonal lull, by encouraging the carrying out of all kinds of construction jobs that can be done just as well in winter as in summer.

It is difficult to assess the results of these campaigns from a national point of view, but reports indicate that wherever local campaigns have been pursued actively, they have been effective in increasing employment and economic activity in general. In addition, the Federal Cabinet recently issued a directive to all its agencies, instructing them to arrange their construction programs so that plans and specifications, tender calls, contract awards and the various stages of construction will be timed to provide the maximum amount of winter work for the construction and allied trades.

At the fourth meeting of the joint committee held in Ottawa on August 19, 1957, it was decided that an even more active campaign will be carried out during the coming winter. A special ten minute film on seasonal employment entitled "It's a Crime" has been produced by the Department of Labour, and will be shown across the country. In addition, as many as possible of the mass media of communication, — the press, radio, television, direct mail, and special publications —will be used by the Joint Committee and the agencies associated with it to carry the following message to the people of Canada:

Winter Construction — Why Not?

"It was not so very long ago that it was common practice in the Canadian building industry to close down all jobs completely as soon as the first snow fell and to leave them closed down until spring. Today, practices have changed. Large construction jobs are normally kept going through the winter, and now the same trend is taking place in housing and other smaller construction jobs.

"Technological changes in the building industry provide a large part of the explanation for this. Another factor is the substantial improvement that has occurred over recent years in winter building techniques. These developments have made it both possible and practical to carry on most types of construction throughout the winter even under our cold weather conditions.

"The fact that winter work is feasible does not necessarily mean that it is automatically carried on throughout the winter months. Technological improvements have created a situation where work in most cases can be carried on, but customs, habits, and traditions of former years die hard, and often work is still closed down anyway. What is needed is a change in our habits of thought which will bring our action more into line with technological possibilities.

"Construction at any time requires careful planning. When this is done architects and construction men agree that any additional costs of winter building are negligible, especially when outdoor work is well advanced when the coldest weather comes. There is usually additional expense involved for heating and protective shelter but there are offsetting factors such as the greater availability of skilled labour, building materials and equipment, and an earlier occupancy of the building by the owner, which may result in a saving in rents and financing costs.

"A bulletin entitled WINTER CONSTRUCTION has recently been issued by the Division of Building Research of the National Research Council in Ottawa in its "Better Building Series." This booklet, which is available at ten cents per copy, outlines the essential precautions that should be taken in the wintertime in such things as excavations, painting, concrete and masonry work. It also clearly indicates that building activities can be carried forward during the winter months provided proper advance planning is done."

It was agreed that the Joint Committee should again write to the Provincial Governments, the chartered banks and other large organizations which either paid for or influenced the timing of construction operations, pointing out the anticipated problems of seasonal unemployment during the coming winter and asking for their continued support and co-operation in increasing the volume of wintertime construction. Letters would also be sent to the presidents of the various member organizations of the joint committee thanking them for past co-operation, and asking them to keep up their promotional activities through speeches, articles, convention resolutions, etc.

The following resolution was passed:

WHEREAS: Construction workers constitute the largest single group of seasonably unemployed workers during the winter months in Canada, and

WHEREAS: Those employed in housebuilding operation are particularly affected, and

WHEREAS: Decisions concerning the mortgage arrangements for the construction of homes during the coming winter will have to be made within the next month to enable proper planning and the "closing in" of buildings before the extreme winter conditions commence, and

WHEREAS: The shortage of mortgage funds is a basic problem retarding the construction of new houses and there is a likelihood of increased unemployment this winter, and

WHEREAS: Central Mortgage and Housing Corporation has authority to advance direct loans for housing construction and agreement was reached with private lending institutions to increase their allocation of investment funds to residental mortgages,

THEREFORE BE IT RESOLVED: That the National Joint Committee on Wintertime Construction strongly recommend that the Federal Government take steps to increase the supply of mortgage funds for the 1957-58 winter housing program.

Raymond Brunet of Hull, Quebec, chairman of the Joint Committee on Wintertime Construction, welcomed the announcement made shortly after the meeting by the Federal Government that $150 millions in additional mortgage funds will be made available for housing operations.

New Awards for Technical Papers

In keeping with the Institute's policy of expanding its technical activities is the announcement of Council relative to two new prizes recently established. One of these is for a paper in the electrical field and the other in the mechanical field.

The Sir George Nelson Award

The John Inglis Company Limited and their associate, the English Electric Company of Canada Limited, have completed arrangements with Council for the establishment of the Sir George Nelson Prize to commemorate the visit of Sir George, then president of the Institution of Electrical Engineers, to the seventieth annual meeting of the Institute held in Montreal in 1956. The prize is the sum of two hundred and fifty dollars awarded annually for a worthy paper presented by a member of the Institute, under 35 years of age, on the "science of electrical engineering".

The Robert W. Angus Medal

The second award is established by two well known Members of the Institute — Messrs. H. G. Thompson and W. L. Thompson, and is in honour of Professor Emeritus R. W. Angus, Hon. M.E.I.C., who for over fifty years taught mechanical engineering at the University of Toronto. The award is in the form of a medal and will be presented for the best paper of the prize year on a mechanical engineering subject within a prescribed area. Funds have been deposited with the Institute whereby the award can be made in perpetuity.

These are two outstanding contributions to the Institute and to the profession. The Council of the Institute appreciates greatly the generosity of the donors and hopes that many young men will thereby become encouraged to greater efforts in these two fields.

Not counting Honorary Memberships, this brings to thirty the number of awards on the Institute's calendar. It is an impressive number, which fact, along with a realization of the broad field covered, indicates the long life of the Institute and the variety of its interests. However, there is still room for more prizes and any member who may be interested may obtain details by writing to Headquarters.

The rules and regulations that apply will be published shortly.

Nominees for Office

The report of the Nominating Committee, as accepted by Council at the meeting held on September 20th, 1957, is published for the information of all corporate members as required by Sections 19 and 40 of the by-laws:

Vice-Presidents

°Zone B (Province of Ontario)	H. G. Conn	Kingston, Ont.
°Zone C (Province of Quebec)	E. T. Buchanan	Grand'Mere, Que.
°Zone D (Maritime Provinces)	Grant R. Jack	St. John's, Nfld.

Councillors

†Vancouver	F. M. Cazalet
†Edmonton	S. K. Hampton
†Lethbridge	David Cramer
†Calgary	T. D. Stanley
†Saskatchewan	W. M. Berry
†Winnipeg	N. M. Hall
†Sault Ste. Marie	Wm. Douglas Adams
†North Eastern Ontario	A. A. Kidd
†Huronia	E. L. Cavana
†Sarnia	R. A. McGeachy
†Kitchener	L. J. R. Sanders
†Hamilton	E. T. W. Bailey
†Niagara Peninsula	Paul E. Buss
‡Toronto	E. R. Davis
†Peterborough	P. F. Peele
‡Ottawa	W. A. Capelle
†Cornwall	Howard E. Meadd
§Montreal	E. D. Gray-Donald Leo Roy
†Quebec	B. O. Baker
†Northern New Brunswick	W. F. Hosking
†Moncton	A. W. Purdy
†North Nova Scotia	Robert S. Morrow
†Halifax	G. F. Vail
†Cape Breton	M. R. Campbell

° One Vice-President to be elected for two years
† One councillor to be elected for two years
‡ One councillor to be elected for three years
§ Two councillors to be elected for three years each

Simplified Student Application

Simplified application forms for students membership have been designed and printed in English and French, ready for distribution at the beginning of the fall university session.

The delegates of the student conference held in conjunction with the annual meeting of the Institute last June, recommended that simpler forms be designed for use in universities. They thought that the questions regarding engineering experience in the old forms did not apply to most of the engineering students at the time they applied for membership.

The new forms were designed especially for students of engineering at Canadian universities, whence the great majority of applications for student membership come. The old form will still be used by candidates who are qualifying through apprenticeship and examination and by post-graduate students not yet eligible for Junior membership.

The principal requirement remains unchanged. Each application whether submitted on the old or the new form, must bear the signature of a sponsor who is a corporate member of the Institute. The E.I.C. Faculty Representative may act in this capacity for candidates from his university.

Some Thoughts About Confederation

by a member of the Institute

During these days, when it seems to some of us that confederation is making its way forward at a disappointing pace, let us take a fresh look at some of the principal points that we can identify, and hold to, to keep our thoughts "on course" in line with the destination we have set out to reach.

As engineers in Canada we want:—

(a) A unified and recognized voice in the conduct of our affairs, and in the nation's affairs.

(b) A single standard of admission to professional status, with adequate safeguards.

(c) An efficient system for the acquirement and interflow of technical knowledge, and

(d) A minimum, but fair, annual charge for these services.

These are, and must continue to be, the main objectives of those who are charged with the responsibility of exploring the ways and means. Finding out what can be done about it is not easy, no easier in its way than confederation of the nation was ninety years ago. Why not help these men, to the very limit of our separate abilities. At least we can shape opinion by our attitude and conversation.

It has been suggested that some people, a small minority, are dragging their feet in the course of the present negotiations. If there are any such persons they are standing in the path of a torrent. Regardless of what has been done by the committees in charge of the exploratory work, no one can evade the fact that the members of our profession in Canada have developed, within themselves, a climate of opinion overwhelmingly in favour of confederation — soon — in some workable form. This is the torrent.

No single organization, contemplating its part in such a professional commonwealth, need have a single fear for its identity IF — its purposes and aims are those of service and progress. These aims survive any temporary change, and provide a guarantee of emergence again as vital parts in the next stage of development. Any segment of the profession without such faith in itself can not have much to offer.

It is appropriate at this point to remember the words of a great Canadian at a critical stage of the last war. Planning was badly fouled up, and progress seemed to be dangerously slow. He opened an important meeting with this statement. "There is no problem that can not be solved around a conference table, by men of good will, who have come there determined to solve it."

Let's get around the table!

EDITOR'S NOTE. The member who submitted this article, and whose letter is filed at headquarters, has requested that his name be withheld from publication.

Harry F. Bennett Fund

The trustees of the Harry F. Bennett Education Fund of the Institute are happy to report a very active season in the 1956-57 scholastic year. Applications for loans were received from 40 engineering undergraduates and one postgraduate at seven institutions, and all but five were granted in amounts varying from $50 to $250 and totalling $7,500. The bulk of the applications this year came from men at the Nova Scotia Technical College at Halifax, 29 out of the 41 being from that source. Six applications were from Laval students, two from McGill, and one each from Mount Allison, University of New Brunswick, Queen's and the University of Alberta.

It is of interest to note that seven of the applicants asked for a second or third loan, but none was granted an amount to exceed a total of $450, which is set as the maximum to any one man. A post-graduate student who has paid up two former loans has applied for and received a further loan.

While this money was being sent to these promising and deserving students other money was of course coming in to Headquarters as repayments from recipients of former loans. The total thus received in the year ending December 31, 1956 was $4,315 in repayment and $215 in interest. The loans outstanding at the year end amounted to $17,323.

The trustees, feeling that the fund should be used on occasion for educational purposes other than loans to students, gave a $1,000 bond to the Institute toward the cost of educational films.

Dr. Otto Holden of Toronto became a trustee during the year, to replace V. A. McKillop, who resigned to become president of the Institute. The other trustees are Hugh C. Nourse and Dr. Irving Tait of Montreal, the former being due to retire at the time of this annual meeting, after over four years' service.

Otto Holden,
Hugh C. Nourse,
Irving R. Tait, Trustees,
May, 1957.

Annual Meeting, 1958

Engineering Institute of Canada

Chateau Frontenac, Quebec City, May 21, 22, 23

Engineering Literature in Russia

Over a period of several months the Institute has been receiving enquiries from libraries and other organizations in Russia relative to an exchange of publications and other technical literature.

It is indeed interesting to see how much literature of this kind is available in Russia. For example, the State Public Library in Leningrad Center has sent a list of publications which they would be glad to exchange with the Institute. The list shows a most interesting group of subjects and a total of 93 separate and regular technical publications.

With the reports made in this country relative to state controlled activities in Russia, it is interesting to see that all of the 93 publications, with the exception of two, are published by industries, technical societies and research institutes.

Before the second world war the Engineering Institute used to receive a few Russian publications. No attempt was made to translate the articles but the publications were on display in the reading room and quite a few people showed an interest in them. It is just possible that some of the present members would like to see some of the new periodicals, and therefore some attention is being given to the matter to see which of all these publications might be brought to the Institute in exchange for the *Engineering Journal*.

Exhibition of Photographs, 1957

The winning entries of the 1957 exhibition of photographs have been selected. The exhibition, one of the features of the 71st annual meeting of the Institute at Banff, contained over 90 photographs. Five photographs were selected as the best of the show. They are listed in random order:

"230-kv Oil Circuit Breakers"
The British Thomson - Houston Co. (Canada) Ltd.

"Chipping of 3,350-hp. Impulse Turbine Runner Buckets"
Dominion Engineering Company Ltd.

"Manotick Bridge"
C. C. Parker and Associates.

"Coquihalla River Crossing near Hope, B.C."
Canadian Bechtel Ltd.

"M. V. 'Bluenose' Ready for Launching"
Davie Shipbuilding Ltd.

Award of merit certificates are being sent to the exhibitors of the winning photographs. Publication of these five photographs begins in this issue, below.

Arrangements are being made to send the collection to the Universities across Canada, for exhibition during the 1957-1958 session. It may also be possible to arrange exhibitions in places open to the general public. The first exhibition of the season was held in Eaton's Montreal Store during the week of September 16 to 21.

Some of the branches may be able to arrange exhibitions locally, to stimulate interest in engineering. Public libraries, high-schools, or the showrooms of downtown buildings would be suitable places to display the pictures. Besides showing the general public some of the work done by engineers, such exhibitions would encourage young people to think of engineering as a career.

Requests for bookings should be sent to headquarters as early as possible.

"Manotick Bridge". Entry of C. C. Parker and Associates to E.I.C. Photographic Exhibit, 1957.

Evening Education

A wide selection of engineering and scientific courses are now available to many of those who seek to improve their technical education in evening classes.

It is most encouraging to observe how our Canadian universities are doing their best to ever widen and improve the educational services they offer. This is particularly noteworthy in the fields of engineering and science, and has been spurred on, no doubt, by the present shortage of technical manpower in this country.

Programs of 1957-58 university extension courses recently received, from Ecole Polytechnique and McGill for examples, show that they are offering evening instruction this year in as many as twenty-five different technical and allied subjects. Students of all ages from 17 to 70 are reported to be enrolled, mostly from that large group of persons who must spend their daytime hours in earning a living.

Due to the very wide scope of the modern engineering field, most of these courses are designed for the undergraduate level, but there are some that will be recognized as giving credits toward engineering graduation. Most are intended, basically, to advance the individual's knowledge along some specialized line of work.

Similar extension courses are offered at other Canadian universities, so it is not the intention to suggest that such activity is confined to the two named above. The purposes of this article are two-fold, to make readers aware of what is being done in this field, and to congratulate those hard-working persons throughout our colleges who are striving to cope with the growing demand for more scientific education.

Some details of these courses are available in the Institute library, but it is suggested that anyone seeking more information should apply directly to the registrar of the university of his choice. The *Journal* will try to provide further news of these activities as it reaches headquarters.

Journal Content

The current issue is the second *Journal* in which the technical section is devoted mainly to information about the St. Lawrence Seaway. The earlier one was the September, 1956, issue.

The remaining *Journals* for 1957 will maintain a high standard of interest.

November will be a "Northern issue", in which the Canadian North will be discussed in technical papers, as follows: A Power Plan for the Yukon River Waters, by J. M. Wardle, M.E.I.C.; The Peace River and Alaska Gas Gathering System, by A. L. Berry, M.E.I.C., and B. L. Moreau, M.E.I.C. Hunting Associates will contribute a paper on Aerial Survey Methods. There will also be information on the DEW-Line.

The December issue will include information on foundations, structure, services and equipment for C.N.R.'s Queen Elizabeth Hotel in Montreal.

New Institutions for the Teaching of Engineering

In response to the increase in the enrolment in engineering and the even greater increase which will take place in the future, many institutions of learning in Canada have started engineering courses, or have extended existing partial courses.

Among the institutions which have recently adopted complete courses to a degree are The University of Western Ontario at London; Hamilton College (McMaster University), Hamilton; Essex College (Assumption University) Windsor, Ontario; Waterloo College, Waterloo, Ontario; Ottawa and Carleton Universities at Ottawa; and the University of Sherbrooke at Sherbrooke, Quebec.

In addition to these universities where engineering will now be taught for all years, Sir George Williams College in Montreal has inaugurated new classes in engineering covering the first three years of a five-year course. It is expected most of the work of Sir George will be done in night classes, although the full course will be operated in the daytime as well.

From time to time the *Engineering Journal* proposes to describe the work of these institutions which are either new in the field or are expanding their previous efforts, so that engineers across Canada may know more of the great expansion which is taking place in the field of education for engineers.

"Personally, I'll be happy when the whole damn bunch take off for the moon!"

Reprinted with permission from *The New Yorker*

THIRTY-FIVE YEARS AGO

Comment on the Journal of October, 1922

The report of the 36th General Professional Meeting at Winnipeg was the major item appearing in the October 1922 issue. Under the chairmanship of President J. G. Sullivan, some 300 members heard Mayor F. O. Fowler pay tribute to the profession in general and to the service to the community by Mr. Sullivan and by General Ruttan, former City Engineer of Winnipeg.

E. V. Caton presented a paper on 'Extensions to the Hydro-Electric system of Winnipeg', while F. H. Martin, chief engineer, Manitoba Power Co., described his company's power development at Great Falls. The following day delegates visited this project and the Point du Bois plant of the Winnipeg Hydro, travelling by special train. The third day was devoted to papers and discussions on Boxcar Unloaders, Fuel values of Alberta coals, Action of Alkaline ground waters on Portland cement, and Considerations for a Road Policy.

Guests of the evening at the annual banquet included Hon. W. R. Clubb, Minister of Public Works of Manitoba; D. C. Coleman, vice-president, Canadian Pacific Railway; Rev. Dr. Leslie Pidgeon, D.D., and A. W. McLimont, vice-president and general manager, Manitoba Power Co., and Past-President Col. J. S. Dennis, M.E.I.C.

Employment of Engineers

Editorially, it was noted that the last several months had seen a gradual improvement in employment conditions for engineers. A joint committee, under the chairmanship of J. G. Christie, representing the A. S. C. E., A. S. M. E., A. I. E. E., A.I.M.M.E. and A.S.H.V.E. was noted, purpose of which was to draw up a Code of Ethics to be adopted by all engineering societies. Tribute was paid editorially to the late David Thompson, one of Canada's most famous explorers, who had died unnoticed more than half a century ago. A memorial to him had been opened on August 30 at Windermere, B.C.

Under Branch News, organization of the Lakehead Branch of the Institute on September 12, 1922 was noted, under branch chairmanship of G. H. Burbidge, M.E.I.C., of Port Arthur. The Toronto Branch news recorded the Ontario Legislature was about to take up the question of consolidation of town planning legislation, while a committee in Toronto was drafting a town planning bill to be submitted to this Parliamentary Committee. The November 15 Branch meeting would discuss the draft bill.

Hon. F. C. Biggs, Ontario Minister of Public Works, had addressed a meeting of the Hamilton Branch in September, his subject being 'Ontario Highways'. The Ottawa Branch noted an important conference on Lake of the Woods Regulation had been held in September, attended by the Canadian Prime Minister and Governor Prens of Minnesota. Governor Prens was a strong advocate of the early commencement of the St. Lawrence Navigation and Power project.

Ottawa news also noted the return of Controller of Surveys A. M. Narraway, M.E.I.C., D.L.S. from an interesting trip through Western Canada for the Topographical Surveys Branch. The trip included a 1,000 mile seaplane flight from Victoria Beach, Man., northeast to Ontario boundary, thence to The Pas and over the Churchill and Reindeer rivers. Parties engaged on surveying the Alberta-B.C. boundary were also visited as well as parties in the Grande Prairie district and parties in Saskatchewan and Alberta.

K. H. Marsh, M.E.I.C., chief engineer of the Dominion Iron and Steel Co., presented a paper at the opening meeting of the winter session of the Cape Breton Branch. His subject was construction and operation of the blast furnace. He traced development of the present day furnace from the early variety known as the Catalan forge, through the various stages of increased height and hearth, with the introduction of the hot blast, the closed top, with utilization of the waste gases.

The Montreal Branch recorded the resignation of J. L. Busfield, M.E.I.C., as secretary of the Branch due to his duties in connection with the Hydro-Electric Inquiry Commission of Ontario, and the appointment of E. A. Ryan, A.M.E.I.C. as his successor.

Under 'Correspondence' an open letter from A. G. Graham, A.M.E.I.C., care Stewart and McDonnell, Gold Coast Harbours, Seccondee, Gold Coast Colony was published. Noting that Majors Crysdale and Silcox were with him and all were engaged on preliminary work for construction of a harbour at Takoradi, it observed that all material for railway grades was moved by baskets and headwork, requiring careful supervision. An accompanying photo showed five pith-helmeted engineers in white suits and black bow ties; A. G. Graham, A.M.E.I.C., Major Angus Stewart, A.M.E.I.C., Major C. R. Crysdale, M.E.I.C., Col. McDonald, and S. C. Arnett.

The Advertisers

Thirty five years of evolution in consulting services may be observed by comparing the professional cards in the October 1922 issue with those of today. Of the twenty consulting engineers or companies mentioned, none have display cards in the current issue. While in 1922 all had their offices in Montreal, Toronto and Ottawa, of the thirty five firms whose cards appear in the current issue 22 have offices in the central provinces, four in the Prairie Provinces, five in British Columbia; and four have headquarters in the central provinces with branches in the west.

An advertisement by Canadian Westinghouse Co. Ltd., displays a cut of a then recently completed bascule bridge over the Burlington Beach Canal at Hamilton, Ont., soon to be replaced by the Burlington Skyway.

H.G.C.

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

ONTARIO

Engineers in the News

Army Headquarters, Ottawa, has announced the appointment of Col. **J. R. Dunlop**, P.Eng., as Military Attache, at Prague. To assume these new responsibilities, Col. Dunlop vacates the appointment of director of Electrical and Mechanical Engineering at Army Headquarters, a post he has held since 1952.

Col. Dunlop obtained his degree in mechanical engineering at McGill in 1935 and first served with the 3rd Divisions Signals. At the start of the Second World War he was appointed to the Ordnance Corps, which at that time was responsible for mechanical engineering. Proceeding overseas in 1941 he held a series of appointments with the 2nd Canadian Corps and the 4th Armoured Division.

After the war he served for two years as assistant director of electrical and mechanical engineering, attended the Canadian Staff College, commanded the R.C.E.M.E. School at Barriefield, Ont., and in 1952 was appointed to the post he has just left.

Lieut. Col **Robert A. Campbell**, P.Eng., of National Defence Headquarters, Ottawa, has been promoted to the rank of colonel and appointed director of electrical and mechanical engineering at Army Headquarters. In this appointment, which became effective on August 2nd, Col. Campbell succeeds Col. J. R. Dunlop, P.Eng., now Military Attache at Prague.

Col. Campbell has been serving in the Canadian Army since 1939 and after service with the R.C.O.C. and R.C.-E.M.E. in the United Kingdom and Northwest Europe, was posted in 1946 to Army H.Q. as inspector of R.C.O.C. and R.C.E.M.E. services for Canada. Latterly, he has held the appointment of assistant director of electrical and mechanical engineering.

John Hunt, P.Eng., and **R. Clare Mott**, P.Eng., two professional engineers of Falconbridge Nickel Mines Ltd., have been appointed to vice-presidencies in the company.

John Hunt, who is vice-president-projects, is an engineering graduate of the Scottish St. Andrew's University and has been with the Falconbridge organization since 1932. Prior to the recent appointment he was manager of the project division.

R. Clare Mott, P.Eng., obtained his degree in mining engineering at Queen's University, Kingston, and has been with Falconbridge for 22 years. He has been manager of the mining and reduction division of Sudbury district for 6 years. During 1953 and 1954 he represented the Mining branch on Council of the Association and has since been a member of several committees.

Nicholas Chlumecky, P. Eng., has accepted the post of chief engineer, the Rockiron Company Ltd., Sudbury, Ont. He was formerly assistant mine shiftboss at Falconbridge Nickel Mines.

F. S. Hutton, P.Eng., of the Canadian National Railways, Toronto, has been promoted to the position of assistant to the chief engineer, Central Region.

John B. Wilkes, P.Eng., **Gordon F. Wetherall**, P.Eng. and **Robert S. Chapman**, P.Eng., have received further appointments with the Ontario Department of Highways.

Mr. Wilkes moves to Toronto as district engineer from Ottawa, where he has held the position since 1954. Mr. Wetherall, who has been district engineer at New Liskeard for the past three years, moves to Ottawa in the same capacity. Mr. Chapman becomes district engineer at New Liskeard after serving in Ottawa as the district construction engineer since 1954.

Charles M. Bishop, P.Eng., has joined the staff of Humphreys & Glasgow (Canada) Ltd., 837 Eglinton Avenue West, Toronto 10, Ont. The firm is engaged is the design, process engineering and construction for the petroleum, petrochemical and chemical industries and is associated with Humphreys & Glasgow Ltd., a well known British company.

Mr. Bishop was formerly with R. V. Anderson & Associates Ltd., Toronto.

Dr. Robert Sandri, P. Eng., is employed as an associate research officer at National Research Council, Ottawa. Prior to accepting this appointment he was with the Canadian Westinghouse Co. Ltd., at Hamilton.

B. I. F. Breakey, P.Eng., has been appointed vice-president and general manager of the New Consolidated Canadian Exploration, Ltd., 2-8 King St. East, Toronto. He has also been appointed a director of Canpet Explorations Ltd., an oil company with head offices in Calgary. In this appointment he is the Canadian representative of the Consolidated Gold Fields of South Africa.

Leonard H. Harper, P.Eng., who is a project engineer with Defence Construction (1951) Ltd., is located at the R.C.A.F. Station, Rockcliffe, Ont. He is also engaged in work at Shirley Bay and Connaught Ranges.

Fred R. Dorward, P.Eng., is now engaged in electrical consulting work with Crowther, MacKay & Associates, Ltd., 522 Northern Hardware Building, Edmonton. He was earlier with the Canadian General Electric Co. Ltd.

R. J. Brule, P. Eng., is technical service manager with the Minnesota Mining and Manufacturing of Canada Ltd., London, Ont. Before moving to London he was on the engineering staff of the Northern Electric Co. Ltd., at Belleville, Ont.

J. W. Carmichael, P.Eng., of the Harbours and Rivers engineering branch of the Department of Public Works of Canada, has been transferred from Ottawa, to Halifax, N.S.

Richard W. Braddock, P.Eng., has moved from Hamilton to Windsor, Ont. He has accepted the position of a design engineer with Giffels & Vallet of Canada Ltd., engineering consultants. Mr. Braddock was formerly in the City Engineers office of Hamilton, Ont.

G. Moes, P.Eng., announces the establishment of a consulting service covering technical evaluations, witness tests and reports on electrical equipment, materials and specifications. His address is 226 North Shore Boulevard East, Burlington, Ont.

Mr. Moes, who was born in Holland and graduated in electrical and mechanical engineering from the University of Liverpool, recently retired as manager of the Testing Laboratories of the Canadian Standards Association, and has had a wide experience in his special field in more than 30 years connection with the electrical industry in Canada, the United Kingdom and Europe.

M. W. Hotchkin, P.Eng., and **J. C. Adamson**, P.Eng. have been elected to the board of directors of Little Long Lac Gold Mines Ltd.

Mr. Hotchkin, who was president of the Association last year, is vice-president in charge of Wright-Hargreaves Mines Ltd. He is also a past president of the Ontario Mining Association and past vice-president of the Canadian Institute of Mining and Metallurgy.

Mr. Adamson is vice - president in charge of operations of Lake Shore Mines Ltd., which company he joined in 1931. He is likewise a past-president of the Ontario Mining Association

William M. Price, P.Eng., of the Canadian Pacific Railway, has been transferred from Manitowadge, Ont., where he was resident engineer, to Sudbury, Ont., where he is engaged in the same capacity.

John C. Ormond, P.Eng., has recently been granted his release from the Canadian Army (Regular) and has accepted a position as a staff engineer in the mechanical department of the Aluminum Company of Canada Ltd., Isle Maligne, Que.

A graduate in mechanical engineering from Nova Scotia Technical College, he joined R.C.E.M.E. in 1951 and has been stationed in various parts of Canada as well as in Japan. Latterly he has been planning offices at Army Headquarters in Ottawa in the Directorate of Electrical and Mechanical Engineer.

Medal Winners

By coincidence the two winners of the Association's Gold Medal awards for the academic session 1956-7 have completed courses in electrical engineering. The medal-winner at the University of Toronto is **Jan Alexander Norton**, B.A.Sc., of Toronto, and at Queen's University, **Peter William McBurney**, B.Sc., of Ottawa.

This annual award by the Association of Professional Engineers of Ontario is made to the student in the final undergraduate year in the engineering faculty of the University of Toronto and Queen's University, Kingston, who obtains the highest academic standing in the final year. It is in the form of a gold medal and a gift of technical books to the approximate value of fifty dollars.

John M. S. Cherry, P.Eng., of Downsview, Ont., who was formerly employed by J. B. Parkin & Co., is now with the Department of Public Work, dams, docks and locks division, as assistant hydraulics engineer.

W. B. Redman, P.Eng., of Toronto, has recently retired from the Canadian National Railways after more than 37 years service.

Mr. Redman graduated in civil engineering from the University of Toronto in 1915 and served in Canada and overseas with the Canadian Expeditionary Force until 1919. At this time he joined the engineering staff of the Canadian National Railways and was with the company until his retirement on July 31.

Neville E. Hale, P.Eng., has been elected to the board of directors of the newly-formed Gresham Transformers (Canada) Ltd., of 518 Evans Ave., Toronto. He has also been retained as technical consultant.

Mr. Hale is also electrical consultant to Fetherstonhough & Kent, patent attorneys of Toronto, Winnipeg and Calgary, and has a consulting practice in patent development with offices at 129 Queen St., Niagara-on-the-Lake, Ont.

Charles A. Mott, P.Eng., completed 38 years of continuous service with the Corporation of the City of Belleville, on June 30. For twenty-eight year of these years he has been city engineer.

Mr. Mott started work in the engineering department of the city in July, 1919. In 1929 he was to have reported to Trenton, Ont., as its town engineer. At that time, however, then city engineer of Belleville, Charles B. Campbell, died from injuries sustained in a motor accident. Through the intervention of Belleville's Mayor and several of the members of Council, Trenton agreed to release Mr. Mott from the earlier undertaking and on June 1st, 1929 he was appointed City Engineer of Belleville.

Mr. Mott, who is a veteran of the First World War, has been a member of the Association of Professional Engineers of Ontario, since its early years. He is justly proud of his long years of public service in Belleville.

ALBERTA

(Abstracted from The Alberta Professional Engineer September 1957)

Is Basic Engineering Enough?

The much discussed shortage of engineers has led to the attitude that our universities should turn out engineering graduates in an ever-increasing volume. However, at the same time we must consider that our expanding profession is actually requiring increased education.

Engineers today have found their way into fields which at one time were not in any way associated with our profession and technical advances of recent years have broadened the scope of engineering theory and practice. In the face of these developments it is unrealistic to expect universities to produce graduates today as adequately trained, proportionately speaking, as graduates of twenty years ago within the confines of the same space of time.

Universities are continuously faced with the problem of adjusting the engineering curriculum; balancing course content against available time and specialization against generalization.

Guiding Principle. Guiding principle in selection of a curriculum is the provision of a program of Basic Engineering. Analysing such a program we find it contains a number of courses of a non-engineering nature.

There is the necessity for adequate grounding in the sciences upon which engineering is based, further training in the Englsh language beyond the high school level, and the introduction of so-called cultural subjects, now a trend in broadening engineering subjects. The balance of the program must consist of introductory courses in particular phases of the various branches. In the teaching of these applied science courses an essential objective is the demonstration of the engineering method.

The engineering student should develop the ability to critically analyse a given problem and logically choose a method of solution. Mastering of the engineering method by the undergraduate is of more importance than the amassing of numerous specialized tools in a specific area of study.

Supplementing the Program. How can a program of basic engineering be supplemented? We cannot agree with the attitude that upon completion of an undergraduate program a student is quite capable of going the rest of the way alone. A certain amount of self education is desirable but more formal study is necessary.

One solution is study and discussion programs within engineering firms and departments.

University short courses can play a part. The main objective of these courses is to outline specific phases of a particular subject and to stimulate further study by the individual.

Graduate Study. Graduate study, the most satisfactory means of rounding out an engineering education, sometimes considered of greatest value to those who plan to enter the research and academic fields, should be designed for the purpose of further preparation for any engineering employment. Such programs can be entirely devoted to specialization in specific fields.

Employers of engineers should play a prominent part in the extension of engineering education. Encouragement must be given to those considering graduate work and it should be recommended for those who might benefit by it. Financial assistance should be made available in greater volume in the form of bursaries and fellowships. Present university facilities are not adequate for an increased volume of graduate students. Employers should feel the responsibility of offering finances for the improvement of graduate schools since they will ultimately benefit.

We expect our graduating engineers to have a foundation in basic engineering, but is that sufficient? In an expanding profession we must deal with an attendant expansion in our educational requirements.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

James Edward Beatty, M.E.I.C., retired engineer of the Canadian Pacific Railways, eastern lines, maintenance of way department died in Toronto on August 14, 1957.

A cousin of the late Sir Edward Beatty, former president of the Canadian Pacific Railway, Mr. Beatty was born at Parry Sound, Ont., on June 6, 1872. A graduate of the Royal Military College in 1894 his first engineering assignments were with the Toronto, Hamilton and Buffalo Railway, and with the Los Angeles, Pacific and Crows Nest Branch of the C.P.R. Around the turn of the century he worked on the territory of the White Pass and Yukon Railway and the Klondyke Mines Railway. He also held the qualifications of Dominion Land Surveyor. He served as resident engineer on the construction of the Guelph and Goderich Railway in 1904 and was promoted to engineer on the Schreiber division in 1910. In 1911 he was appointed assistant engineer of construction, eastern lines, C.P.R., and divisional engineer for years later. In 1915 he was district engineer at Saint John, N.B., and also served in the same capacity in the general superintendent's office at Montreal. He was made district engineer of the Quebec district in 1916 and was appointed engineer, maintenance of way, eastern lines in 1933.

He joined the Institute in 1905 as an Associate Member and transferred to Member in 1915.

Colin Dugald McTavish MacKintosh, M.E.I.C., retired consulting engineer with the Canadian Pacific Railway, Vancouver, died at Victoria, B.C., on May 12, 1957.

His birthplace Auckland, N.Z., Mr. MacKintosh was born on September 24, 1882. He was educated as a civil engineer at the Glasgow and West of Scotland Technical College, the Inverness Royal Academy, and served an apprenticeship with a Glasgow consulting engineering firm from 1899 until 1905. In his early years in this country, to which he migrated in 1905, he worked as rodman, draftsman, and instrumentman on construction with the Canadian Pacific Railway. Within the next few years he was named division engineer for the Saskatchewan division of the Railway. In 1915 he held the appointment of superintendent of the Medicine Hat Division. He then took over the Lethbridge Division. Succeeding appointments took him to Edmonton, Winnipeg and Kenora. In 1941 he was division engineer and assistant superintendent of the railway at Victoria. Named engineer in charge of the then new Nanaimo terminus in 1947, this was followed by his appointment as engineer in charge of the Esquimalt and Nanaimo Railway Company at Victoria, B.C. He became a consulting engineer for the Pacific Great Eastern Railway in 1950 and two years later extended this work to the Canadian Pacific Railway Company. He retired in 1955.

Mr. MacKintosh joined the Institute in 1911 and was transferred to Member in 1922. He attained Life Membership in the Institute in 1947.

Frank Leslie Davis, M.E.I.C., district airway engineer, since 1951 for the Department of Transport for Air, Montreal Air Port, Dorval, Que., died on August 11, 1957.

Mr. Davis came to this country from England where he was born on November 20, 1890 at Gloucester.

He attended high school at Newport, Eng., undertook three years training at Newport Technical Institute and became an articled pupil with a Newport firm. On his arrival in Canada in 1911 he worked as a leveller and draughtsman with the eastern division of the Canadian Pacific Railway and as a draughtsman on the construction of the Pacific Great Eastern Railway at Vancouver. In 1914 he joined the Canadian Field Artillery and served overseas, until 1919. On his return to civil life he was named to the staff of the North American Magnesite Producing Company Limited, at Calumet, Que. In 1921 he joined J. A. Grant and Company Ltd., engineers and contractors at St. John, N.B. and was engineer in charge of construction for the firm. He was assistant engineer on the staff of the John S. Metcalf Company on the construction of a grain elevator for the Montreal Harbour Commissioners in 1924. He was also associated with the International Paper Company at Montreal, and the Gatineau Power Company at Hastings, Ont., before joining the Department of National Defence, civil aviation department, as a district engineer in 1936. The following year he joined the Department of Transport, civil aviation department as a district airways engineer at Nakina, Ont. In 1946 he was named supervising engineer of aerodromes for the Department.

Mr. Davis became an Associate Member of the Institute in 1924, transferred to Member in 1940.

Charles McKay Hare, M.E.I.C., of the Quebec Metallurigcal Industries, Ottawa, died on July 6, 1957 in that city.

Born at Woodstock, N.B., on January 30, 1906, he attended schools in the Maritime provinces and later attained a B.Sc. degree in civil engineering at McGill University in 1929.

His first graduate work was with the Dominion Bridge Company Limited, at Lachine, Que., as a structural steel detailer. Shortly after this he was for two years associated with the Atlas Construction Company and the Standard Dredging Company on West Saint John harbour improvements. In 1936 he joined the Arntfield Gold Mines Limited working first as a surface transitman and as an engineer foreman in charge of construction camps and roads. The following year he became underground surveyor and then chief underground surveyor. In 1939 he was employed with Noranda Mines Limited as a surveyor and draftsman for the construction and mechanical department. During World War II he served with the Ministry of Aircraft Production as a civilian engineer in England and in West Africa. He returned to Canada in 1944. Since that time, apart from his work with Quebec Metallurgical Industries he worked as city engineer at Rouyn, Que., in 1949, with the Indian Affairs Branch of the Department of Citizenship and Immigration, Ottawa, in 1952, and with Cobalt Chemicals Limited, at Cobalt, Ont., the following year.

Mr. Hare joined the Institute in 1928 as a Student Member. He became a Member in 1941.

David D. Clerk, M.E.I.C., consulting engineer of Quebec City, Que., died on July 30, 1957 in that city.

Mr. Clerk was born at Montreal on February 6, 1901. He studied engineering at the Ecole Polytechnique, Montreal, and was awarded a B.Sc.A. degree from that university in 1924. For the first six years of his career he was associated with the Amusite Asphalt Ltd., and Robertson and Janin Ltd. contractors. In 1930 he joined the Department of Agriculture for the Province of Quebec. From assistant chief of the drainage section, he became chief and then chief of the rural engineering division and finally president of the drainage bureau for the provincial government. In 1945 he went into private practice and remained in this work until the time of his death. He was also named manager of the city of Chicoutimi, Que., in 1949.

Mr. Clerk joined the Institute in 1945 as a Member.

Alvin Norman Andrew, JR.E.I.C., who was employed with the Aluminum Company of Canada Limited, Shipshaw, Que., for several years, died at Chicoutimi, Que., on August 30, 1956.

Born at Morden, Man., on August 5, 1927, Mr. Andrew received his early education at Morden andd then went on to study engineering at the University of Manitoba. A graduate of the class of 1951 he worked for a time with the Province of Manitoba. In 1952 he moved to Arvida, Que., and joined the Aluminum Company of Canada hydraulics department, Shipshaw, Que. He later became assistant civil engineer.

Mr. Andrew joined the Institute as a Student Member and transferred to Junior in 1951.

Personals

News of the Personal Activities of Members of the Institute

Dr. D. B. Steinman, M.E.I.C., consulting engineer of New York was awarded the Gold Medal of the Americas by the Chamber of Commerce of Latin America. The gold medal carried the inscription "To Dr. D. B. Steinman, Builder of Inter-American Bridge of Good Will, August 28, 1957." The presentation of the award to Dr. Steinman was accompanied by a luncheon held in his honour and the reading of a citation.

He was at the same time named Honourary Life Member of the Chamber of Commerce of Latin America in U.S.A. Inc.

Lt. Col. C. Gordon Kirby, M.B.E., M.E.I.C., has taken up the new appointment of Command electrical and mechanical engineer of the Prairie Command at Winnipeg, Man.

Lt. Col. Kirby received his B.Sc. degree in mechanical engineering from the University of Saskatchewan in 1936. Before the war he was employed at the Vulcan Iron Works in Winnipeg, Man.

Robert H. Winters, M.E.I.C., former Minister of Public Works this month took over the Canadian operations of the Rio Tinto Company as its president. A British corporation, the Rio Tinto Company, specializes in the development of natural resources in many countries.

Mr. Winters worked his way up as an engineer in industry, with the Northern Electric Company Limited at Montreal during the thirties. He entered politics in 1945 in his home constituency of Lunenburg, N.S., following extensive overseas service in World War II.

Lt. Col. C. G. Kirby, M.B.E., M.E.I.C.

Dr. S. M. Breuning, M.E.I.C., was some time ago appointed to the staff of the University of Alberta to assist in the greatly expanded program of activity in the highway transportation field, set up at that university.

Professor Breuning last served the Joint Research Highway Project of the Massachusetts Institute of Technology, sponsored by the Massachusetts Department of Public Works. He graduated from a technical university at Stuttgart, Germany, with a diploma in engineering. He did graduate work in civil engineering at M.I.T. from 1953 to 1957 in transportation, soils mechanics and city planning. He also studied transportation and business administration at the Harvard School of business administration at M.I.T. He came to Canada in 1951.

Paul E. Pesonen, M.E.I.C., executive vice-president and member of the board of directors of Canadian Javelin, Limited, Montreal has resigned from this office. Now located in California he is engaged in consulting work in the field of mining.

H. M. Smith, M.E.I.C., recently in charge of the C.B.C. station at Sackville, N.B., has gone to Kingston, Jamaica. On loan for the purpose of developing a broadcasting system in that country, he will be with the Ministry of Development at Kingston.

Dr. J. Krol, M.E.I.C., until recently associated with the University of Manitoba

S. M. Breuning, M.E.I.C.

R. V. Tomkins, M.E.I.C.

now teaches in Atlanta, Georgia, where he is professor of industrial engineering at the Georgia Institute of Technology.

Dr. Krol joined the staff of the University of Manitoba in 1954. He is a graduate of the Universities of Warsaw and London.

Colonel W. A. Capelle, M.E.I.C., director of engineer development at Army headquarters, Ottawa, has been appointed Commander, Canadian Base Units, Middle East. Colonel Capelle was the 1957 choice for chairman of the Ottawa Branch of the Institute.

Colonel Capelle saw extensive service in World War II, retiring as senior officer with the Royal Engineers, Airfields, at headquarters, First Canadian Army in 1945.

He rejoined the regular army in 1947. In 1952 he was promoted to the rank of colonel and appointed director of works, A.H.Q. Two years later he was appointed director of engineer development.

Louis O'Sullivan, M.E.I.C., was some time ago named a commissioner of the Quebec Hydro-Electric Commission.

General executive assistant of the company since 1942 he was given thirty-four years of experience with the organization, at one time known as the Montreal Light Heat and Power Company.

R. V. Tomkins, M.E.I.C., has opened a consulting engineering office in Regina, Sask. under the name of R. V. Tomkins

Consulting Limited. The firm specializes in work related to industrial minerals. Mr. Tomkins was director of the industrial minerals research branch of the Saskatchewan Department of Mineral Resources from 1952 to 1954, and worked for that department since 1947. He held the position of chief engineer with Western Clay Products Limited prior to entering private practice.

Mr. Tomkins is a 1944 graduate in chemical engineering from the University of Saskatchewan.

R. A. Crysler, M.E.I.C., has been appointed a consultant with the firm of M. M. Dillon and Company Limited. He became a director of the company in 1953 and manager of the company's Toronto office.

A graduate of the University of Toronto in civil engineering he was employed for two years as senior structural engineer for the H. K. Ferguson Company of Cleveland, Ohio, and for a period of five years was in charge of structural design for Chapman and Oxley, Toronto, Ont. In 1932 he joined the staff of the Canada Cement Company Limited as structural engineer. During his service with this company he acted in a consulting capacity to the Federal Government and to certain Provincial Government Departments as well as to engineers and architects throughout Canada in connection with the design and supervision of large concrete structures.

Mr. Crysler specializes in reinforced concrete design and construction, architectural monolithic concrete construction, soil cement paving and concrete mix design and control.

J. J. Heffernan, M.E.I.C., has been appointed a partner in the company of M. M. Dillon and Company Limited, in charge of development.

Mr. Heffernan is a graduate of the University of Toronto with a B.A.Sc. degree in mechanical engineering and

J. A. Grant, M.E.I.C.

J. J. Heffernan, M.E.I.C.

an M.A.Sc. in public health engineering.

Prior to joining the company staff he served with the R.C.E. as works engineer in Manitoba including the construction at Ft. Churchill. He later held the appointment of second-in-command of the design section of the directorate of works at army headquarters.

Since 1954 he has been employed by the company as senior project engineer.

W. K. Clawson, M.E.I.C., of M. M. Dillon and Company Limited, consulting engineers, has been named a vice-president of the company and manager of the Toronto office of the firm.

A graduate of the University of Toronto in civil engineering in 1940, he served with the R.C.E. until 1945.

He became a member of the firm in 1951 and has since headed the company's municipal department. Prior to 1951 he served for one year on the staff of the Horton Steel Company Limited and for five years as county engineer for the County of Middlesex, Ont.

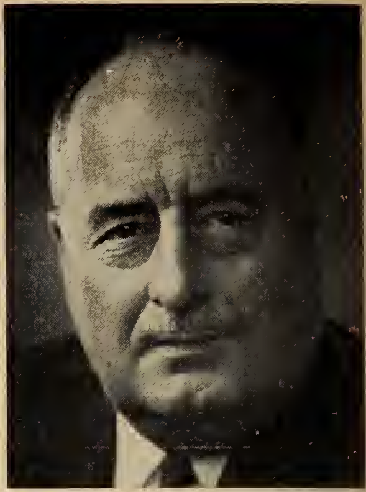
Arthur FitzPatrick, M.E.I.C., who has carried on business in Calgary for some time as a consulting engineer has joined the staff of the Research Council of Alberta in Edmonton. His position is that of industrial engineer.

Mr. FitzPatrick gained a B.Sc. degree at the University of Alberta in 1949, later qualifying for a degree in psychology in 1955, also at that University.

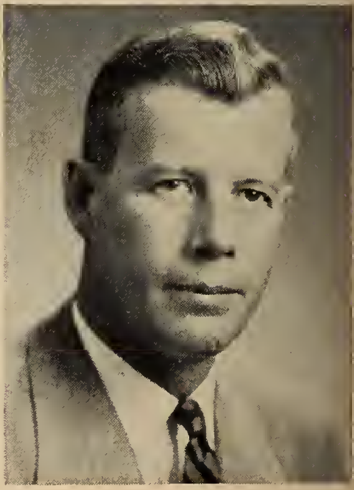
S. H. deJong, M.E.I.C., a University of British Columbia engineering professor has been appointed to serve a three-year term on the committee of the American Society of Engineering Education.

Professor deJong has been appointed to the surveying and mapping committee of the civil engineering division of the society.

J. A. Grant, M.E.I.C., chairman of the Belleville Branch of the Institute is a graduate of McGill University and an official of the Northern Electric Com-



R. A. Crysler, M.E.I.C.



W. K. Clawson, M.E.I.C.

pany Limited, communications equipment division.

Now chief engineer of the Belleville plant Mr. Grant has also served as assistant superintendent of equipment engineering. With the firm for a number of years, he began his career with the Belleterre Quebec Mines Limited, at Belleterre, Que.

Mr. Grant was secretary-treasurer of the Belleville Branch in 1955.

Brigadier J. R. B. Jones, M.E.I.C., who has held office as commander of the New Brunswick area for the past three years at Fredericton, has been posted to Whitehorse, Y.T. as commander and chief engineer of the Northwest Highway System. Brigadier Jones served as senior highway engineer on the Northwest Highway System at an earlier date in his career.

Karl E. Gustafson, M.E.I.C., a 1940 graduate in mining engineering from McGill University has completed his mining construction assignment in Greece. Mr. Gustafson was associated with Pierce Management Inc. of Scranton, Pa. and the Public Power Corpora-

tion of Athens, Greece. He is now chief engineer for Pierce Management Inc. at the firm's anthracite operations at Coaldale, Pa., carried out under the name of Coaldale Mining Company Inc.

Lloyd L. Marshall, M.E.I.C., serving as chairman of the Northern New Brunswick Branch of the Institute is a design engineer with the Bathurst Power and Paper Company Ltd., at Bathurst, N.B.

Mr. Marshall graduated from the Nova Scotia Technical College in 1954 with a B.Eng. degree in mechanical engineering.

E. E. Lord, M.E.I.C., vice-president and manager of the firm of Smith Brothers and Wilson Limited, contractors and engineer, of Regina, Sask., has retired from active professional life following nearly thirty years association with the company. He will reside at Victoria, B.C.

Active in engineering since early in this century Mr. Lord had his training at the University of British Columbia, spent four years in the service of the Royal Engineers, B.E.F., and then followed his career in China. An assistant chief engineer on a river improvement project in Manchuria, he continued to live in that part of Asia until 1928. It was at that time that he accepted work with Smith Brothers and Wilson Ltd.

Mr. Lord assumed the duties held until recently, of vice-president and manager, in 1939.

H. E. Moller, M.E.I.C., of Defence Construction (1951) Limited, has been transferred from head office at Ottawa to Comox, B.C. His new appointment is that of project engineer.

A. J. Williams, M.E.I.C., of Saskatchewan, former chief reservoir engineer of the provincial natural resources department, mines branch, has been named director of the petroleum and natural gas branch of the department of mineral resources.

Mr. Williams followed his career in Eastern Canada for ten years working in the munitions field and as a consulting geologist before joining the staff of the Province of Saskatchewan in 1947.

A. B. Barnes, M.E.I.C., who graduated from the University of Birmingham, England, class of 1950, has joined the Boeing Airplane Company of Seattle, Washington as a design engineer.

R. C. Peck, M.E.I.C., prevously assistant works manager of the Shawinigan works of the Aluminum Company of Canada has been appointed plant manager at Etobicoke, Ont.

L. L. Marshall, M.E.I.C.

With the company a number of years Mr. Peck has served in Canada, British Guiana and Great Britain as well as attending the "Centre D'Etudes Industrielles" at Geneva.

He graduated from the University of Alberta, class of 1940, in civil engineering.

George J. Crane, M.E.I.C., who has been associated for a number of years with the Electric Reduction Company of Can-

• PERSONALS

ada has taken over the post of general manager and chief engineer of Huron Chemicals Ltd., Toronto.

Mr. Crane studied electrical engineering at the University of British Columbia and graduated in the class of 1941.

John F. Ford, M.E.I.C., has been appointed general manager of Rush and Tompkins (Canada) Limited, Edmonton, Alta., general contractors. Prior to joining this firm in July he was contracts manager with Perini Ltd., Toronto.

A graduate in civil engineering from the University of Toronto in 1939, Mr. Ford has been active in general construction work in various phases, with time out for duty with the Royal Canadian Engineers from 1942 to 1946.

W. M. Price, M.E.I.C., is among recent transfers. Formerly at Sudbury with the Canadian Pacific Railway, he has taken on the duties of resident engineer in the regional engineer's office at Toronto. Mr. Price is working on eastern region engineering projects.

V. R. Cox, M.E.I.C., formerly division engineer with the C.N.R. at Kamloops, B.C., has taken up residence in Van-

H. A. Sabier, M.E.I.C.

couver where he is now assistant district engineer.

He is a 1949 graduate, University of Alberta in civil engineering.

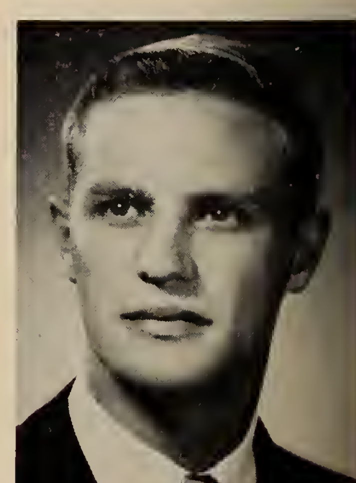
H. A. Sabier, M.E.I.C., supervising engineer, special projects division, Department of Highways and Transportation, at Regina, Sask., has been awarded the Canadian Salt Good Roads Scholarship for study at the School of Engineering, Purdue University.

Mr. Sabier graduated from the University of Saskatchewan in civil engineering in 1954 with great distinction.

J. B. Hockman, M.E.I.C., has recently been appointed project manager on the new highway bridge crossing the St. John River at Fredericton, N.B.

He has been with Grant-Mills Ltd. since 1944 when he joined the firm as field engineer. In 1952 he became chief engineer.

Thomas W. Rogers, JR.E.I.C., has received the appointment of sales engineer assigned to the Montreal office, with the Canadian Blower and Forge Company Limited.



T. W. Rogers, M.E.I.C.

• PERSONALS

Mr. Rogers is a 1955 graduate of McGill University in mechanical engineering. After completing training courses at the company's Kitchener Training Center and in the Buffalo engineering and research departments, he gained preliminary sales engineering experience in the Kitchener area.

Douglas M. McKim, Jr.E.I.C., who has been active in the affairs of the Institute as chairman of the Shawinigan Falls Branch and secretary-treasurer, and chairman of the nominating committee of the St Maurice Valley Branch, now serves as chairman of the latter group.

A divisional engineer at Shawinigan Chemicals Limited, Mr. McKim holds a B.Eng. degree gained at McGill University in 1947.

P. E. Wade, Jr.E.I.C., is one of five winners of the C.G.R.A. scholarships awarded to highway engineers. Highways analyst with the Department of Highways, Ontario, at Toronto he has been awarded the Armco Drainage Good Roads Fellowship for study at the Institute of Transportation and Traffic Engineering of the University of California. He is a 1949 graduate of the University of Toronto.

D. M. McKim, Jr.E.I.C.

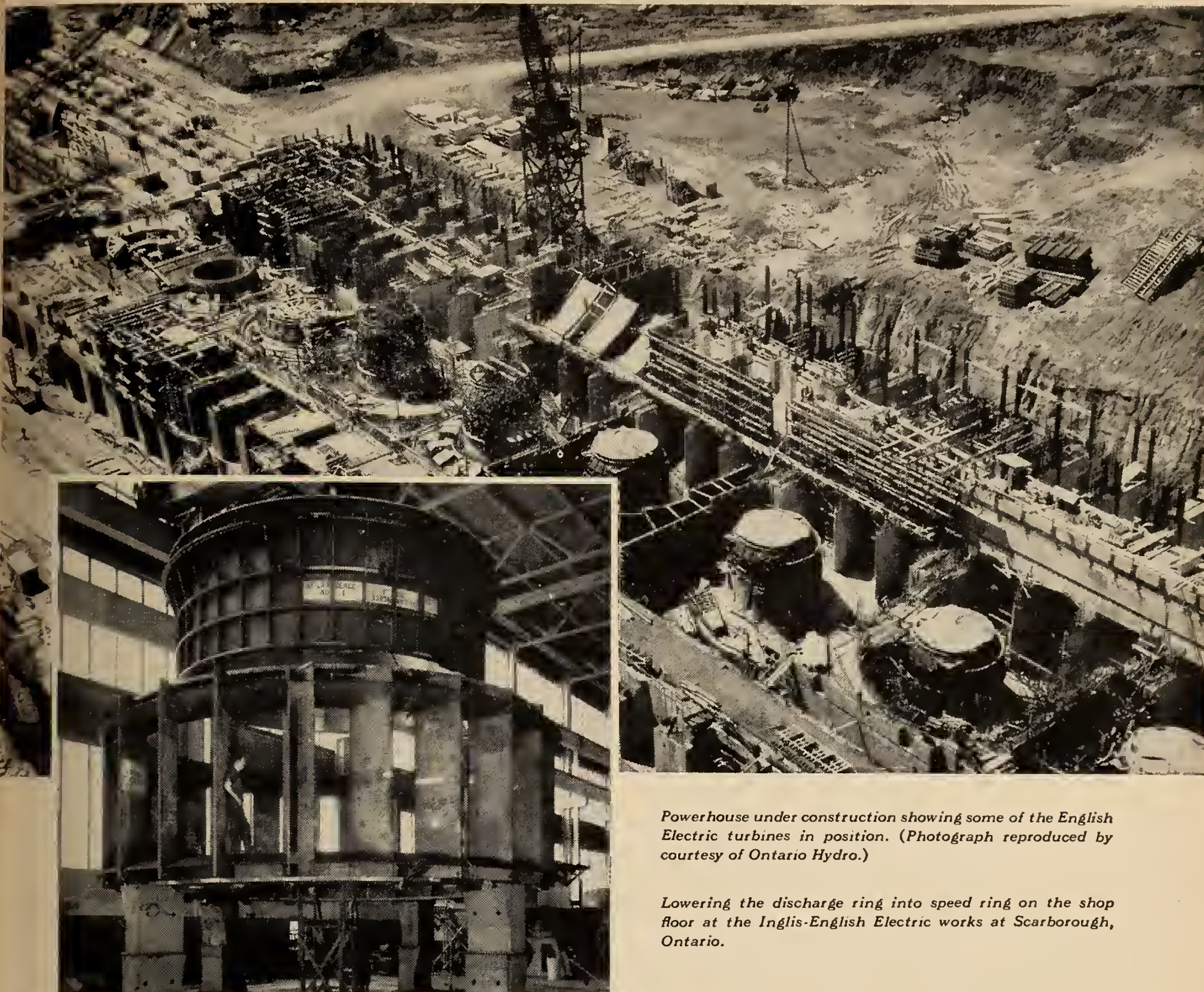
P. E. Wade, Jr.E.I.C.

W. Naves, Jr.E.I.C., formerly special engineer with the headquarters staff of Canadian National Railways at Montreal has moved to Ontario, where he has accepted an appointment with the Napanee Iron Works division of the International Equipment Company Limited.

Mr. Graves graduated from McGill University and has thus far pursued a career of electrical engineering and engineering-economic studies.

E. D. Manchul, Jr.E.I.C., of the Department of Public Works, Fort William, Ont., has been transferred to the St. John's, Nfld. office of the Harbours and Rivers Engineering Branch. His duties are those of assistant district engineer.

Wing Commander A. F. Avant, Jr.E.I.C., who has been posted at Ottawa for some time as director of Maritime, transport and training requirements is now stationed at Toronto. Associated with the R.C.A.F. Staff College he is a member



• PERSONALS

of the directing staff of the school.

Wing Comander Avant received a B.Sc. in mechanical engineering at the University of Saskatchewan in 1949.

I. H. Anderson, S.E.I.C., of the Department of Water Resources, Alberta at Edmonton, has been awarded the Standard Gravel Good Roads Scholarship. He is a 1957 graduate University of Alberta.

I. H. Anderson, S.E.I.C.

Charles L. Pelton, S.E.I.C., a 1956 graduate of Queen's University is employed with the Canadian General Electric Company at Peterborough, Ont. He is with the design engineering group of the motor and generator department. He is concerned with the control equipment for diesel-electric locomotives as built by the Montreal Locomotive Works.

M. R. Cossitt, S.E.I.C., a 1957 graduate of the University of New Brunswick in mechanical engineering is with the Polymer Corporation Limited, Sarnia, Ont., in the design section of the organization.

David J. McColm, S.E.I.C., who was awarded a B.Sc. degree in civil engineering at the University of New Brunswick this spring has joined the engineering staff of Dibblee Construction Company Limited at Ottawa, Ont.

J. Robert Burton, S.E.I.C., of Queen's University class of 1957, in civil engineering has accepted an appointment with the Dibblee Construction Company Ltd. at Ottawa, in the engineering department of the firm.

C. N. Ellert, S.E.I.C., a 1957 graduate of the University of Alberta has been awarded the Union Tractor Good Roads Scholarship for further study at that university.

Mr. Ellert is resident highway engineer with Alberta Department of Highways, at Edmonton.

C. N. Ellert, S.E.I.C.

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NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

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Innovation in Tunnels

The construction of the first prefabricated all reinforced concrete tunnel with a rectangular crossection on this Continent was recently visited by some 200 members of the Vancouver Branch.

The site was the 16½ million dollar Deas Island Tunnel constructed by Narod — Dawson & Hall (tunnel sections) and Kiewitt — Rayond — B.C. Bridge (approaches). The tunnel was designed by the Foundation of Canada Engineering Corporation and Christiani and Nielsen of Canada, Ltd.

The project is being undertaken by B. C. Toll Highways and Bridges Authority under supervision of the Department of Highways.

Deas Island Tunnel

Shown in the above photographs of the Deas Island Tunnel in British Columbia are (left) tunnel segments under construction, and the tunnel approach and ventilation building.

The 4 traffic lane tunnel is built in segments in a dry dock excavated on the bank of the mighty Fraser River. The excavation is protected by a dyke and a wellpoint system keeping the site bone dry.

The outside dimensions of the tunnel segments are 24 ft. x 78 ft. x 344 ft. and consist of 4 compartments: two for carrying 2 lanes of traffic each, and two smaller ones for ventillation and carrying water, drainage, electric energy and other services.

The casting of the tunnel segments will be completed in October 1957. In November, at low water stage of the Fraser River, a suitable trench will be dredged along the proposed route of the tunnel, then the dyke protecting the dry dock opened and the tunnel segments, after being made watertight by appropriate bulkheads, will be floated to their permanent positions.

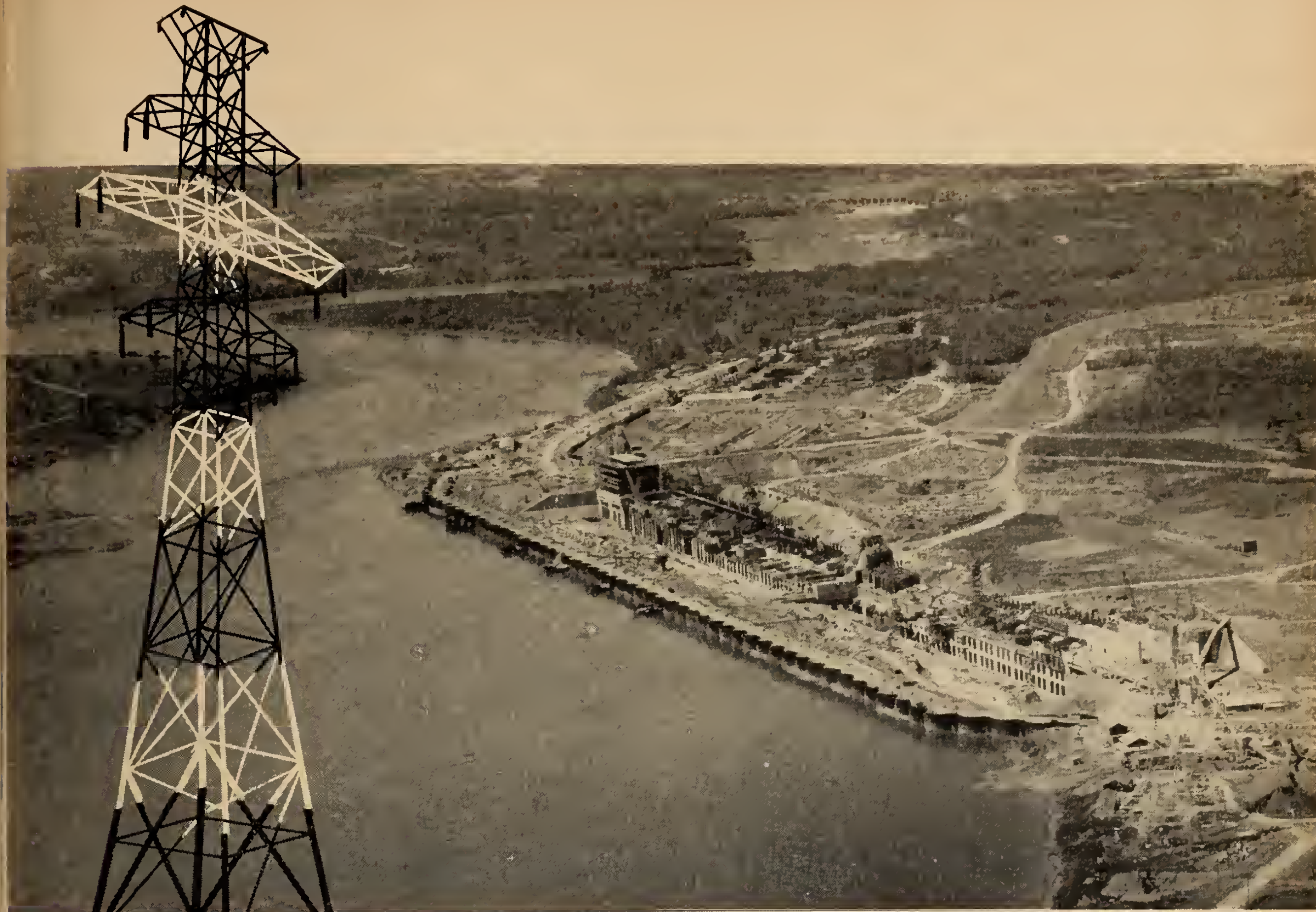
The construction is so planned as to limit to absolute minimum the work of divers whose visibility would be very problematic in the muddy water.

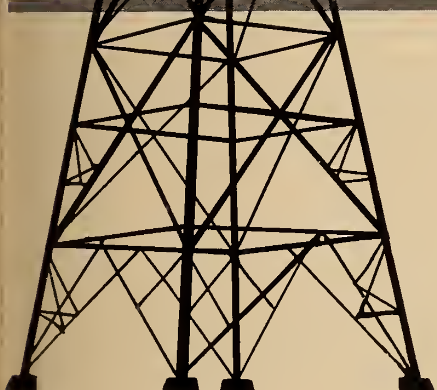
Joining Done in Dry

Joining of the tunnel segments will be done in the dry. To that purpose the segments after being floated to their positions over the dredged out trench will be sunk and pulled against a rubber gasket collar of the adjoining segment of the structure creating thus a watertight

Montreal

Herewith the results of a recent fishing expedition to the Restigouche River. On the right is Carlyle Gerow, M.E.I.C., M.C.I.M., secretary-treasurer of The Canadian Institute of Mining & Metallurgy with his best catch, a twenty pound salmon. On the left is Austin Wright, M.C.I.M., M.E.I.C., General Secretary of The Engineering Institute of Canada with his best catch, a one ounce parr. Mr. Gerow's look of superiority and exultation can be well understood! Another member of the expedition was John Bates, M.E.I.C., M.C.I.M., whose luck was no better than that of the general secretary.





SETTING THE STAGE

In 1910, Ontario Hydro met a power demand of 4,000 kilowatts —the lid of Ontario's vast treasure chest of natural resources had then hardly been opened. Last year, the demand was over 1000 times greater—4.5 million kilowatts.

As the wheels of industry turn faster and processes become more highly mechanized, development, inventiveness and engineering skill will more than ever be dependent on an abundant supply of electricity.

So the spotlight falls on such mammoth enterprises as the St. Lawrence Power Project, sixteenth new power source in Ontario Hydro's vast expansion program, and on the large thermal generating stations planned for the future.

ONTARIO HYDRO

space between the bulkheads on each element.

Individual segments will be lowered to their final positions with hydraulic jacks supporting each of their corners. After aligning the tunnel to proper elevations sand will be blown in the space between the dredged out trench and the base of the segments to form a permanent bed. At that stage the hydraulic jacks will be withdrawn and the watertight space between the bulkheads filled with concrete to form a permanent joint between the segments of the tunnel.

Watertightness of the concrete shell of the tunnel will be achieved by a rigid control of the concrete mix itself and the coating of hot asphalt and fiberglass. Covering the structure with a blanket of rock will complete the construction.

Mr. Ole Bentzen, the project manager of the construction expects that similarly to the Rotterdam tunnel built by Christiani and Nielsen on the same principles, the settlement of the structure should be confined to several milimetres.

Two ventillation buildings at each approach will be equipped wih ventillating system capable of renewing the air in the whole tunnel every two minutes.

Television screens located in the traffic control room above the ventilation buildings will allow the traffic controller to observe the passage of all vehicles inside the tunnel and transmit messages to them by means of loudspeakers and emergency telephones or, if necessary, to stop any car by means of push button operated traffic signals spaced at 172 ft. intervals.

A fireproof centre wall will separate northbound from the southbound traffic. Sprinkling system and alarm boxes together with the powerful ventillation system assures the safety of the tunnel from the smoke and engine exhaust fumes. Carbon monoxide meters will automatically start the exhausters.

Lighting Features

The tunnel will be illuminated by fluorescent lighting. Overhead louvres admitting daylight at the entrances to the tunnel will provide a gradual adaptation of drivers' sight from daylight to artificial lighting. The "electronic eyes" will automatically control the intensity of artificial lighting to assure the optimum intensity of illumination from the traffic safety point of view.

The tunnel will provide another connection to Highway 99 leading to U.S.A. border at Blaine (Wash.), and no doubt bring greater prosperity to Ladner, B.C., and its vicinity.

Participants of this very interesting tour were the guests of Narod — Dawson & Hall Ltd. for refreshments.

LETHBRIDGE

R. D. Hall, Jr.E.I.C.,
Secretary-treasurer

Field Trip and Dance

On September 7, 1956 a field trip to the Belly River project of the P.F.R.A., near Waterton, Alta., was held through the kind assistance of the latter organization. After the tour a golf tournament and dinner was held at Kootenay Lodge, Waterton. Following dinner the party was free to attend the Saturday night dance at the Waterton Lakes Hotel.

It is hoped that a full account of the field trip will be available for an early issue of the Journal.

News of Other Societies

Geophysical Congress

A world gathering of scientists converged on Toronto, September 3 to 14 for the Eleventh General Assembly of the International Union of Geodesy and Geophysics.

One of the main interests of the Assembly was to review the progress of the world's greatest scientific adventure, the International Geophysical Year. Theme of several displays was also the I.G.Y.

A trade exhibit of geophysical equipment was presented by thirty leading companies of Canada, the United States and Europe and areas as far apart as Japan and East Germany:

At the Royal Ontario Museum where the opening reception was held, a full-size model of the IGY Vanguard rocket and a working replica of the United States earth satellite was on view to the public. The satellite was provided by the United States National Research Council.

During the I.U.G.G. Assembly the Canadian International Air Show displayed fixed wing aircraft and helicopters, as equipped for air surveys and geophysical work.

Largest overseas group of scientists was from the United Kingdom and numbered about 90. France, the U.S.S.R., Germany, Holland, Italy, Sweden, Japan, Switzerland, Belgium, Spain, and Poland were represented and small groups from about thirty other countries attended. More than 300 American and 150 Canadians participated.

Symposiums held during the meet dealt with Water Balance, the General Circulation of the Ocean; Rock Magnetism, Physical-chemical Interpretation of Terms, magma, crust and substratum, and Geochronology and Radioactivity.

Addresses by E. I. Tolstikov, entitled, "The Arctic and Antarctic Program of the I.G.Y.," and "The Rocket and Satellite Program of the I.G.Y." by Professor L. V. Berkner were heard.

Associations participating in the general assembly, which is held every third year, are: The International Union of Geodesy and Geophysics and the International Association of Seismology and Physics of the Earth's Interior; the International Association of Meteorology; the International Association of Geomagnetism and Aeronomy; the International Association of Physical Oceanography; the International Association of Scientific Hydrology; the International Association of Volcanology.

Each provided a scientific program of importance, in the form of special study groups, reports of technical commissions, and discussions.

The National Research Council of Canada participated for Canada and the National Committee for Canada of I.U.G.G. was headed by chairman Dr. C. S. Beals of the Dominion Observatory, Ottawa.

"Rilem" Conference in Stockholm

Bond and crack formation in reinforced concrete was the subject of an international symposium, held in Stockholm, Sweden, from June 27 to 29, which was attended by two hundred engineers and scientists from twenty-five countries. That a technical subject apparently so detailed should have attracted such world-wide attention might be surprising did it not reflect the keen interest in Europe in the use of very high working stresses in both steel and concrete, and the steadily increasing recognition and use of "ultimate load design" with reinforced concrete.

North American interest was shown by the presence of Raymond C. Reese, new chairman of the A.C.I. Design Code Committee. Of the two hundred participants, however, only eight were from the Western Hemisphere (one each from Argentina, the Dominican Republic and Canada, with five from the U.S.A.) One American paper only was submitted, by D. Watstein and R. G. Mathey of the Division of Building Technology of the National Bureau of Standards, Washington.

Forty-four papers in all were accepted from fifteen of the countries represented at the Symposium. All were preprinted, as were also the summaries by the general reporters for the eight sections into which the main subject was broken down. At the conference itself, even these summaries were presented in abstract only leaving most of the meeting time for general discussion in the two official languages, English and French. This was aided by most skilful combined summary and translation by I. Cyon, an electrical engineer!

Discussion ranged from a three-dimensional mathematical analysis of crack formation, through a consideration of what is meant by a "hair-crack", to a critical analysis of the actual cracks found and measured in large groups of structures in Holland and France. Consensus of the meeting was that, although many aspects of strain cracking in reinforced concrete are not yet fully understood, enough is known to suggest that such cracks are not in general as injurious as are those which are created by corrosion, generally caused by the use of porous concrete, nor those due to shrinkage. Once again, therefore, stress was placed upon the basic necessity of obtaining concrete of the best possible quality, and upon placing it efficiently, if injurious effects upon reinforced concrete units are to be avoided.

Professor Waclaw Olszak of Warsaw, Poland, presented to the meeting the first version in English of a mathematical treatment which he has developed which explains the formation of cracks in reinforced concrete numbers under load, and does so in three dimensions and for non-homogeneous materials, starting with an investigation of principal stresses. Other more simple two-dimensional theories of crack formation were presented and discussed. Some of these relate to the width of crack which may be anticipated and some to the probable spacing of cracks along a beam, the two being interrelated.

The application of the leading theories to the actual results of 150 beam tests was analysed by Professor H. Rusch (of the Technische Hochschule, Munich). By plotting values for the difference between observed and theoretical values for crack spacing, divided by observed values, Dr. Rusch was able to show that all the main theories give results usually with an accuracy of 70%, the formula developed in his own laboratory having a mean accuracy of about 95%.

There was useful discussion about the actual widths of cracks and the slippage of bars and their measurements, an ingenious radiographic technique being described by Professor R. H. Evans and A. Williams of the University of Leeds, England. The one American paper described the determination of the decrease in crack width between the concrete surface and the surface of the reinforcing steel, a finding that was appreciatively mentioned by several discussers.

There was, however, a general feeling that since the width of cracks varies so much, and since cracks rarely form in straight lines, little was to be gained by attempting great accuracy in the measurement of crack widths. This directed attention to a very simple measuring device, described by J. F. Borges and J. A. e Lima of the Laboratoria Nacional de Engenharia Civil, Lisbon, Portugal.

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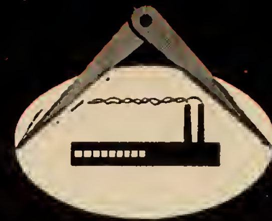

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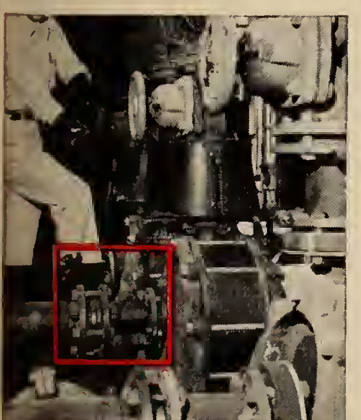

Flexible neoprene connectors resist hydrochloric acid, allow for misalignment between pumps and suction and discharge lines.

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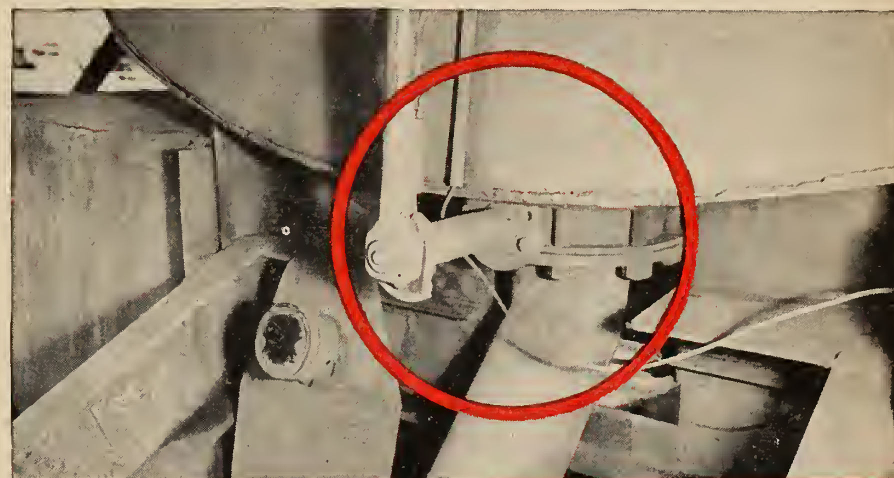
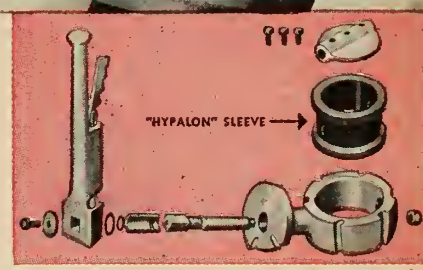


The resilient HYPALON sleeve in this butterfly valve snaps into the ring piece. It acts as both a valve seat and as the gasket between the ring piece and mounting flanges, giving a perfect seal.



ORIGINAL VALVES STILL ON DUTY AFTER TWO YEARS' SERVICE

Industrial Wastes, Inc., of Beaver Falls, Pa., hauls about 2½ million gallons of spent acids each month in its fleet of tank trucks. About two years ago, the company faced the problem of finding an all-purpose tank outlet valve which would give longer service.

They tried a butterfly valve with a sleeve of HYPALON. Here's how it works: An acid-resistant metal damper rotates in a ring piece lined with a HYPALON sleeve. As the valve closes, the metal disk distorts the resilient HYPALON sleeve to form a pressure-tight seal. The sleeve returns to its original shape when the valve is opened.

The resistance of HYPALON to sulfuric, nitric, hydrochloric and hydrofluoric acids has kept the valve in operation for *two years*—with a minimum of maintenance. Can HYPALON help you? This versatile synthetic rubber also has unusual resistance to hardening at elevated temperatures (250° to 350°F.) . . . is virtually ozone-proof . . . and can be fabricated into hose, gaskets, belts, linings or prepared as solution coatings. For more information, clip and mail coupon.

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It consists of a rigid plastic scale upon which are drawn a series of black lines with thicknesses varying from 0.05 mm. to 5 mm. Used for direct visual comparison with cracks in beams, it was reported to be easy to use and to give reasonably accurate results.

Behind all the detailed consideration of crack widths is the supposition that there is probably some critical dimension above which cracks will cause serious trouble through corrosion of the reinforcing steel. After a review of all the evidence presented, Professor Lobry de Bruyn, of the Technische Hogeschool, Delft, Holland, reported that there was still no agreement as to what this dimension was and that other instigators of corrosion, particularly the use of porous concrete, were probably of much more serious moment.

This view was reflected by a report presented by L. Carpentier, chief engineer S.N.C.F., Paris, upon the study of the results of a questionnaire circulated in connection with the very large number of reinforced concrete structures now in use on the French National Railways. Although the replies received were variable in value, since they were subjective to a considerable degree, they did show that transverse cracking has not been harmful in general (although longitudinal cracking of beams has been), the general conclusion being that the survey had revealed nothing to suggest any departure from the standard methods of reinforced concrete design used by S.N.C.F.

A similar conclusion could be drawn from reports presented by Professor A. M. Haas (of the Technische Hogeschool, Delft) upon field surveys of cracking in 165 exposed structures in the Netherlands, and upon 140 protected structures. Using the Dutch rustgrade IV as a criterion, the results showed that only for cracks wider than 0.7 mm. was rusting of the steel always worse than the criterion adopted, and this only for the exposed structures. It was stressed that this result was preliminary only.

Amongst gaps in the present state of knowledge which were stressed were the problems of cracking due to shear stress, and the cracking of reinforced concrete walls under load. Gaps of another sort were highlighted by reports of the chaotic state of nomenclature for reinforced concrete design that was revealed when individual national design specifications were examined. An unusually interesting presentation by Professor Muraschen of Moscow, U.S.S.R., introduced not only a new basis for reinforced concrete design but still further variations in terminology. Professor Muraschen presented a copy of the book in which his new theory is published, to the chairman of the symposium. A rough translation of the title is "Crack Resistance, Stiffness and Strength of Reinforced Concrete". (Copies of the book and of the tentative design code based upon the theory are available in the U.S.)

The meetings featured a good deal of discussion of the pros and cons of the standard pull-out test for bond. Professor

• OTHER SOCIETIES

A. Paduart, of the Free University of Brussels, Belgium, proposed a new set of standard dimensions for pull-out test specimens, based upon the diameter of the bar being tested. This proposal, and a strong suggestion that some action be taken to promote uniformity in nomenclature, was passed by the Conference for consideration to the Permanent Commission of Rilem (under the auspices of which the Symposium was organized), with appropriate reference to the work of the recently activated Technical Committee 71 of I.S.O.

The Symposium was organized and conducted under the distinguished leadership of Dr. Georg Westlund, director of the Swedish Cement and Concrete Research Institute. The papers and discussions will eventually be published in three volumes: inquiries should be addressed to the Secretary of the Conference, Dr. Sven Odman, care of the above noted Institute, Drottn., Kristinas Väg. 26, Stockholm 70, Sweden.

Rilem is the short name of the International Union of Testing and Research Laboratories for Materials and Structure, first formed in 1947. It now has over 400 individual members, representing 250 research organizations in 37 nations. The Secretary General is M. R. L'Hermite, whose office is at 12 Rue Brancion, Paris, France.

Chemical Economics Division

Theme of the inaugural divisional meeting of the Chemical Economics Subject Division of The Chemical Institute of Canada which is being held in Montreal on October 29, 1957 at the Sheraton Mount Royal Hotel is "The Canadian Chemical Industry in 1962."

Keynote speaker for the occasion is J. R Donald, president, J. T. Donald and Company (1956) Limited.

Panels, focussing on trends in the growth and development of the industry will be composed of senior executives of the industry. The panel on "Development and Finance" will be chaired by C. R. Graham, of J. T. Donald and Company (1956) Limited. D. M. Matheson, of Chemical Developments of Canada Limited, will lead the panel on "Purchasing and Traffic", J. A. McCoubrey, of North American Cyanamid, Limited, will chair the panel on "Sales".

During the luncheon session, mutual problems on chemical industry sales and purchasing executives will be discussed by G. T. Bloomer, of Canadian Industries Limited and W. D. Wright of E. B. Eddy and Company.

Feature of this meeting will be the dinner address by Nik Cavell, administrator of the Colombo Plan Administration in Canada. He will speak on the important contribution of his administra-

• OTHER SOCIETIES

tion to the capital expenditure and technical assistance program which Canada is making under the Plan in South East Asia.

This new Division of the Institute formed earlier this year to fill the growing need for another specialized group within the Chemical Institute will concentrate on the commercial and economic aspects of the Canadian chemical and chemical process industries. It will cater to the needs of those engaged in or interested in development, finance, market research, purchasing, sales, advertising, traffic and industrial relations.

Calendar

Soil Mechanics

The eleventh Soil Mechanics Conference will be held at the Building Research Centre, National Research Council, Ottawa, on December 9-10, 1957. These conferences are sponsored by the Associate Committee on Soil and Snow Mechanics of the National Research Council.

Two topics will be featured this year: Bearing Capacity of Piles, and Frost Action. There will be technical papers on the theoretical and practical aspects, and ample opportunity for discussion. All interested people are invited to the conference.

Inquiries should be directed to Mr. Edward Penner, c/o Division of Building Research, National Research Council, Ottawa 2, Ont.

Aeronautical Engineering

Activities of the Institute of the Aeronautical Sciences (2 East 6th St., New York 21, N.Y.) are announced as follows: November 7-8, Weapons System Management Meeting Dallas, Texas, November 25-26; International meeting, Canadian Aeronautical Institute and I.A.S., Montreal, Que.; December 17, the Wright Brothers Lecture; Department of Commerce Auditorium, Washington, D.C.; January 27-31; Twenty-Sixth Annual Meeting Sheraton-Astor Hotel, New York City.

Australian Conference

The Institution of Engineers, Australia has announced that the next meeting of the Commonwealth Engineering Conference will be March 19 to April 2, 1958.

Current proposal for the Conference program is that it will proceed from Sydney by air to Melbourne, from Melbourne to Canberra, by air, and from Canberra to the area of the Snowy Mountains Hydro-Electric Authority. It will return to Canberra on March 30, where it will be adjourned, April 1. Further information may be obtained on writing:

C. D. Harper,
Secretary,
The Institution of Engineers, Australia,
Science House,
Gloucester and Essex Streets,
Sydney, N.S.W.

(Continued on Page 1562)

Library Notes

Additions to the Institute Library

Reviews, Book Notes

Standards

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

AMERICAN SOCIETY FOR TESTING MATERIALS. PROCEEDINGS, 1956

This volume records the accomplishments of the Society for 1956, including a summary of the Proceedings of the fifty-ninth annual meeting.

The reports of the A.S.T.M's eighty technical committees are included, as well as fifty-two technical papers and the discussions on them. Symposia published as Special Technical Publications are listed, as are all papers published in the ASTM Bulletin during the year.

This is an annual publication. (Philadelphia, A.S.T.M., 1957. 1498 p., $12.)

*ASPECTS OF RIVER POLLUTION

This extensive study is divided into fifteen chapters, each devoted to a particular aspect of the subject: nature and effect of pollution; causes; uses of river water; physical characteristics of rivers; sewage disposal and purification; disposal and treatment of trade wastes; etc. Each chapter is provided with a list of references to more detailed treatment of specific subjects, the number of references cited totaling over 1300. Though the book deals mainly with British practice, most of the subject matter has application in other countries. (By L. Klein. Toronto, Butterworth, 1957. 621 p., $14.-50.)

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS

Monday to Friday

9 a.m. — 5 p.m.

*BEARING DESIGN AND APPLICATION

In this practical guide for the machine designer, the bearing is considered from three aspects: the design, including its geometry and tolerances; the materials from which it is made; the lubricant used to minimize wear and tear in its operation. The book is divided into two main parts on rolling bearings and sliding bearings. Useful features are trouble shooting chapters for both types of bearings and a discussion of the selection of bearing class. Much of the material has been provided by the author's consulting practices during the past ten years. (By D. F. Wilcock and E. R. Booser. Toronto, McGraw-Hill, 1957. 464 p., $15.)

*BETON ARME

Simplified calculations for the design of rectangular and T reinforced-concrete structural elements for both elastic and elastoplastic conditions. Much of the data are in tabular form, with explanatory sections and numerical examples for a variety of simple and complex situations. The author's intent is to reduce the amount of work involved by the efficient use of known techniques. (By F. Touchet. Paris, Librairie Polytechnique, 1957. 69 p., 1900 fr.)

BOUNDARY CONTROL AND LEGAL PRINCIPLES

Based on the law of the United States, this book covers the legal principles of boundary control for abstractors, surveyors, title engineers and others who interpret, insure, and locate deed descriptions.

The author, who is a licensed land surveyor in California, covers the following topics: the systems used to describe property; transfer of real property; locating boundaries; reversion rights; riparian and littoral owners; federal mining claims; the duties of the surveyor; and writing deeds. He also includes a brief bibliography on the subject. (By C. M. Brown. New York, Wiley, 1957. 275 p., $7.50.)

CABMA REGISTER OF BRITISH INDUSTRIAL PRODUCTS FOR CANADA, 1957-8

Useful for any purchasing agent, this Register contains a classified list of over 3200 British products available for export, together with the names and addresses of their suppliers. Canadian agents and distributors are also listed. (Canadian Assoc. of British Manufacturers and Agencies. London, Iliffe, 1957. 623 p.)

CANADIAN BUSINESS ADMINISTRATION

Based on a course "Introduction to Business" given at the University of Western Ontario, this book covers business opportunities and organization, finance, production and personnel, and marketing.

As explained in an introductory chapter, the student is assumed to have little or no knowledge of business, but the material in this course should acquaint him with a wide range of problems.

The material is presented in the form of cases to be used for class discussion, and a series of questions is included with each case as an indication of the line of thought to be followed. (By L. W. Sipherd and others. Toronto, McGraw-Hill, 1957. 398 p., $6.95.)

CENTRIFUGAL AND AXIAL FLOW PUMPS, 2ND ED.

This second edition takes into account the developments in the field since the publication of the first edition in 1948. They include the extension of the applications of centrifugal pumps, the increased ranges of head per stage, total pressure, temperature, speed and size, and the progress made in design which has come from a wider knowledge of the flow through the pump. A new chapter has been added on water-hammer problems, that on the centrifugal-jet pump system expanded, and the complete characteristics of mixed flow and axial pumps included in the chapter on

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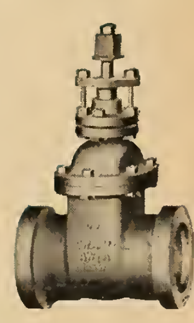

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the operating conditions of centrifugal pumps. Bibliographies are included at the end of each chapter. (By A. J. Stepanoff. New York, Wiley, 1957. 462 p., $12.00.)

CHIMIE MINERALE: THEORIQUE ET EXPERIMENTALE

In this treatise on inorganic chemistry, the author has made use of the electronic theory to explain many of the facts obtained through experiments, relating the reactions of the atoms to their electronic structure.

The first part of the work deals with general chemistry, and covers atomic and molecular theory and chemical reactions. The second, and larger, part is devoted to a study of the elements, arranged in groups according to the periodic table. (By Fernand Gallais. Paris, Masson, 1957. 810 p., 4300 fr.)

THE COMMUTATOR MOTOR, 3RD ED.

One of a series published by Methuen intended to give science students and research workers an outline of various topics, this volume covers the commutator motor.

As the author points out, this is an induction motor to which a commutator has been added, and he includes information on the circle diagram of the former as it is necessary for an understanding of the latter. Other topics covered include speed control, power factor, energy transference, cascade operation, and generator and slip power operation. Those requiring a more detailed mathematical treatment are directed to the references listed in the bibliography. Three items have been added in this revised edition, and other changes have been made to bring the work up-to-date. (By F. J. Teago. Toronto, Ryerson, 1952. 82p., $1.50.)

COST ACCOUNTING, 2ND ED.

The basic principles of cost accounting are stressed in this book which also shows how important cost analysis is for cost control. Largely re-written, this edition includes new material on direct costing, a new treatment of distribution cost accounting, and more information on control of factory overhead costs.

Other topics covered include a comparison of general and cost accounting; the different methods of cost accounting used; overhead charges; the effect of volume on costs and profits; profits and losses resulting from price changes; waste etc. (By C. F. Schlatter and W. J. Schlatter. New York, Wiley, 1957. 725p., $7.25.)

*DATA BOOK FOR CIVIL ENGINEERS, VOLUME 2: SPECIFICATIONS AND COSTS, 3RD ED.

Volume 2 of this three-volume set provides data necessary for preparing specifications for buildings, airports, roads, railroads, bridges, dams, docks, drainage and sewers. Swimming pools athletic fields, and other miscellaneous structures are briefly considered. Relative cost analyses are included for each type of work, and there is a classified glossary of terms. In addition to the extensive amount of practical data presented in this book, the other two volumes of the set provide similarly useful information on design and field practice. (By E. E. Seelye. New York, Wiley, 1957. Various paging, $20.00.)

*THE DEMAND AND SUPPLY OF SCIENTIFIC PERSONNEL

This important study offers evidence that, contrary to many previously published reports, there is no shortage of engineers in the United States. The study consists of five chapters dealing, respectively, with the growth of the technological professions; demand and supply; factors influencing the demand for engineers and chemists; the supply of engineers; the supply and demand for mathematicians and physicists. A considerable amount of statistical data is included in appendixes. (By D. M. Blank and G. J. Stigler. New York, National Bureau of Economic Research, 1957. 200p., $4.00.)

THE DIESEL LOCOMOTIVE

The increasing interest in diesel locomotives in the United Kingdom is reflected in the publication of this volume, which is intended for those actually operating the machines.

After a brief historical introduction, the author covers the basic principles

and construction of the engine; the fuel injection system; electrical, mechanical and hydraulic systems of transmission; auxiliary equipment; safety measures; maintenance and operating troubles, faults and adjustments.

The author was for many years engaged in the design and manufacture of diesel locomotives. (By R. L. Aston. London, Thames and Hudson, Toronto, Longmans, Green, 1957. 116p., $2.50.)

EARTH PRESSURES AND RETAINING WALLS

In this reference book for structural engineers the author has tried to include all the special soil conditions which may be encountered in the design of retaining walls.

The author stresses the principles on which the numerical solutions he gives are based, and includes designs and calculations.

The topics covered are: earth pressures due to cohesive soils; stability and foundations of retaining walls; design principles and requirements, and retaining wall design, with special emphasis on counterfort walls. There is a useful bibliography. (By W. C. Huntington. New York, Wiley, 1957. 534p., $11.50.)

EMPLOYEE BENEFIT PROGRAMS

"Fringe benefits" now play such an important part in the field of employee compensation that this brief outline has been prepared as a guide to discussions in the field of employee benefits.

It covers the Why, What, How and Who of employee benefit programmes, and the various types of benefit plan. The most important of these is protection against income loss, whether from death, retirement, unemployment or injury, while sickness insurance plans are also covered. There is a brief bibliography of selected further reading. (By M. T. Wermel and G. M. Beideman. Pasadena, California Institute of Technology, Industrial Relations Section, 1957. 32p., mimeog., $1.00.)

ENGINEERING PROPERTIES AND APPLICATIONS OF PLASTICS

The characteristics of a variety of plastics are described in this book written for those who work with plastics, and those wanting background information on them.

After an introductory chapter, the different plastics are described separately, in the order of increasing complexity. Also described are methods of manufacture and the engineering, thermal, electrical and optical properties of plastics. (By G. F. Kinney. New York, Wiley, 1957. 278p., $6.75.)

GLASS REINFORCED PLASTICS

The purpose of this book is to describe the raw materials, both resins and glass, used in the manufacture of this type of plastic, the manufacturing techniques, and to discuss the problems of specialized applications. This second edition has been thoroughly revised, and several new chapters added. These new chapters cover epoxide resins, the resin injection moulding process, and applications in chemical plants.

Other topics covered include glass fibres; all the important resins, with particular emphasis on polyesters; techniques of manufacture — commercial moulding, mass production and the manufacture of tubes and rods.

The application of glass reinforced plastics in various fields is discussed, including the manufacture of automobiles, aircraft and boats, the electrical industry, and micellaneous manufactures, for example swimming pools, refrigerators, road signs, sports equipment and building. (Ed. by Philip Morgan. London, Iliffe, Toronto, British Book Service, 1957. 276p., $9.00.)

*HANDBOOK OF RIGGING, 2ND ED.

This second edition of a complete manual of rigging practices serves as a ready reference and guide for expert riggers. New material includes a section on transportation since the rigger is responsible for loading trucks, and includes information on the "overland train" used in transporting loads over deserts and through swamps. There is a chapter on

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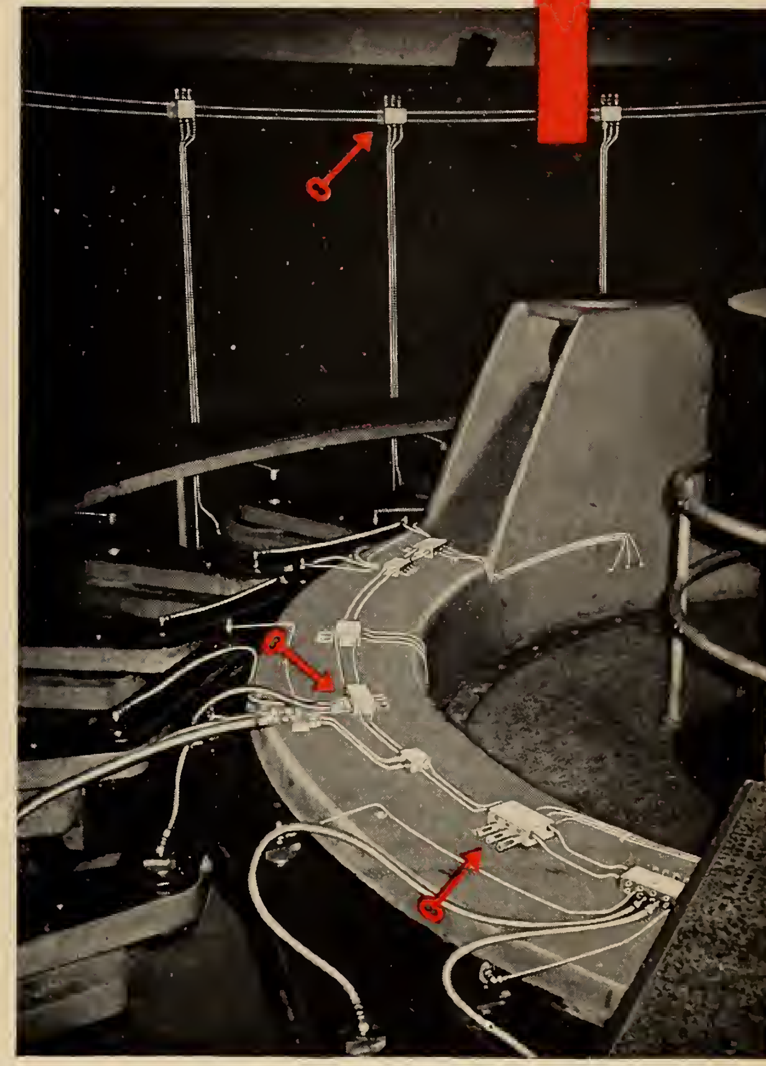

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the actual hitching of slings to loads for hoisting and transporting and for turning suspended loads on their sides or tops as required. There are several chapter on the element of safety in rigging operations. (By W. E. Rossnagel. Toronto, McGraw-Hill, 1957. 342p., $7.-80.)

°HIGH-SPEED SMALL CRAFT

This book deals with the theory and practice of the design and construction of marine craft up to 130 feet in length and of speeds above 15 knots. Fully illustrated with photographs, diagrams, and sectional drawings, the book covers materials, hull and rudder design, propelling machinery and its installation, electric equipment, propellors, model experiments, and speed trials. (By Peter Du Cane. New York, Philosophical Library, 1957. 324p., $15.00.)

INTRODUCTION TO AUTOMATIC DIGITAL COMPUTERS

Intended for those without advanced mathematical training this book shows the use of digital computers in the performance of tedious calculations. Throughout the emphasis is on application rather than further research.

The author explains the functions and capabilities of digital computers, and discusses programming. The various systems of number storage are considered, and following this the author describes the organization of programmes for complicated problems, and the solution of engineering problems using computers. A final section reviews the future prospect for digital computers.

This slim volume should prove most useful as an introduction to the subject, and a more detailed treatment can be found in the books listed in the bibliography. (By R. K. Livesley. Cambridge, University Press, Toronto, Macmillan, 1957. 53p., $1.45.)

LINEAR PROGRAMMING AND INVENTORY MANAGEMENT

These proceedings contain the seventeen papers presented at the second conference on the subject held by Methods Engineering Council, Inc. Many firms are now using linear programming and inventory control to help cut their production costs.

The papers were given by the top men in the field, and outline the experiences of several companies. They show how the methods were used to decide such questions as expansion of facilities, stabilization of production, the most profitable amount of inventory, and production planning.

This is a rapidly expanding field, and much can be learned from the experiences of those already using these methods. Fortunately one does not need to be a mathematician to learn from this book something of what linear programming and inventory control are all about. (Pittsburgh, Methods Engineering Council, Inc., 1957. Various paging, $6.00.)

LLOYD'S OF LONDON: A STUDY IN INDIVIDUALISM

Throughout the world, many people when they think of insurance think of Lloyd's, and the publication of the history of this venerable institution will be of great interest to many entirely unconnected with the insurance world.

The author, who has been engaged in Lloyd's business for fifty years, traces the history of Lloyd's from its beginnings in 1688 in a London coffee house owned by Edward Lloyd to its present unique position as an insurance market. Mr. Gibb has a fascinating tale to tell, and he tells it well, with many humourous touches. (By D. E. W. Gibb. Toronto, Macmillan, 1957. 387p., $5.00.)

°MACHINE LITERATURE SEARCHING

Although the primary concern of this book is machine literature searching, much general information is included on such subjects as problems in indexing, collection of terminology, code development, organization of semantic units, de-


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signing of information retrieval systems and machine language. The focus of the book, however, is the machine and what may be expected from it. The appendix constitutes an excellent bibliography in this and related fields. (By J. W. Perry and others. New York, Interscience Publishers, 1956. 162p., $4.00.)

MANAGEMENT GUIDE TO ELECTRONIC COMPUTERS

This book, written by a consultant on electronic data processing, tries to show the business executive, in non-technical language which jobs can be performed by electronic computers. He also discusses the equipment and its operation, problems connected with its use, and how to choose and install a system.

Wherever possible, the author gives concrete examples to clarify his text, and includes eleven case histories showing company experience with electronic computers in such varied fields as airline seat inventory, actuarial operations, and machine shop scheduling. (By W. D. Bell. Toronto, McGraw-Hill, 1957. 403p., $7.80.)

°THE MANUFACTURE OF IRON AND STEEL. V. 1 IRON PRODUCTION, 2ND ED.

Volume one of this series is a comprehensive survey of the subject of modern methods of iron manufacture from the occurrence and classification of iron ore to the manufacture of ferro-alloys, special irons, and wrought irons. The blast furnace is thoroughly covered with chapters on blast furnace fuels, reactions, slags, equipment, design, refractories, operation and calculations. Several other methods of pig iron production such as the electric reduction furnace are discussed. Many references are included after each chapter, and there is a short bibliography at the end. (By G. R. Bashforth. Toronto, Ryerson, 1957. 306p., $9.00.)

°PRACTICAL AUTOMATION

A practical guide to the installation and use of plant automation. In addition to the general discussions of fundamentals and specific recommendations for planning, operation and management, over 150 actual cases, small and large, in existing plants are described. The text material, profusely illustrated by photographs and diagrams, covers handling, processing, inspection, and maintenance operations, control instrumentation, communication systems, and computer applications. (By L. R. Bittel and others. Toronto, McGraw-Hill, 1957. 376p., $7.50.)

PROCEEDINGS OF THE JOINT CONFERENCE ON COMBUSTION, 1955

Available for the first time in bound form, this volume contains the proceedings of the Conference sponsored jointly by the Institution of Mechanical Engineers and the American Society of Mechanical Engineers. Two meetings were held, one in London and one in Boston, and this volume includes not only the papers presented, but also the discussions upon them which took place at both meeting.

The five sections into which the papers are divided are: general questions of combustion; boilers; industrial furnaces; internal combustion engines; gas turbines. The majority of the papers include references and illustrations. (London, I. Mech. E., New York, A.S.M.E., 1957. 457p., 63/-.)

PULP AND PAPER MANUAL OF CANADA, 1957

Now in its twenty-fifth edition, this useful manual contains all the usual features: new and revised flow charts for some twenty pulp and paper mills; an alphabetical list of machinery, supply and service companies; a classified list of machinery and supplies; trade names; foreign firms and their Canadian representatives. There are also several editorial features. (Gardenvale, Que., National Business Publications, 1957. 479p.)

°QUALITY CONTROL AND STATISTICAL METHODS, 2ND ED.

Intended for those with little knowledge of the field, this second edition presents the most generally useful modern techniques of quality control and statistical methods as applied to indus-

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trial problems of product quality. Subjects covered include the nature and economic objectives of quality, the means of presenting information pertaining to quality, the applications of various types of control charts, the various modifications of control limits, probability distribution and significance of differences and the nature of acceptance sampling. New material has been included on rapid approximate tests of significance, and analysis of variance. (By E. M. Schrock. New York, Reinhold, 1957. 246p., $6.75.)

REINFORCED CONCRETE DESIGNER'S HANDBOOK, 5TH ED.

Now in its fifth edition in just over twenty years, this edition has been re-written to incorporate the recommendations of the 1957 British Standard Code of Practice for reinforced concrete in buildings, including the ultimate-load method of design. Revisions have also been made in the sections on granular and cohesive materials, foundations, slabs subjected to triangular loads, loads on bridges, long columns and the properties of reinforced concrete sections.

The book is divided into four parts, the first of which deals with design, while part two contains tables to be used in design, together with examples of their use. Part three contains additional examples requiring the use of more than one table, and the fourth part deals with specifications and quantities. (By C. E. Reynolds. London, Concrete Publications, 1957. 343p., $4.00.)

ROCKETS, MISSILES, AND SPACE TRAVEL, 3RD ED.

The third edition in thirteen years, this volume has been thoroughly revised and many sections re-written. New material has been included on project Vanguard, on war rockets which were still on the secret list in 1951 when the second edition was published, and on rocket fuels. Many additions have also been made to the bibliography.

This is an eminently readable account covering the past and the present, with a look into the future, although as the author himself says in his foreword 'The probability is high that during the next twelve years it (the future) too will all move into "present".'

The author begins his story with man's early ideas concerning the planets, early attempts at flying and at building rockets. He tells the story of the German developments leading to the building of the V-2, and that of post war U.S. developments, and concludes with a chapter on spaceships. (By Willy Ley. Toronto, Macmillan, 1957. 528p., $7.50.)

RUBBER; FUNDAMENTALS OF ITS SCIENCE AND TECHNOLOGY

The chemistry of rubber, mainly, is discussed in this book. It includes a brief history of rubber and the rubber industry, and discusses in more detail the physical and chemical properties of latex and rubber and all compounds of rubber. The vulcanization and processing of rubber are also covered, as well as synthetic and reclaimed rubbers.

There is a chapter on analyses and tests for rubber and latex and one on the applications of rubber and rubber products. There are many tables, illustrations and diagrams included as well as a bibliography at the end of the book. (By J. LeBras and I. E. Berck, New York, Chemical Publishing, 1957. 464p., $12.00.)

TECHNIQUES OF PLANT MAINTENANCE AND ENGINEERING 1957

The eighth conference on the techniques of plant maintenance was held in Cleveland in January 1957 in conjunction with the National Plant Maintenance and Engineering Show, and this volume includes the papers presented, together with the discussions they provoked.

The majority of the papers as usual can be applied to the maintenance problem in any industry, and deals with such topics as maintenance cost controls; labour relations; effectiveness; training, etc.

The specific maintenance problems of the following industries are also considered: metal working plants; chemical

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plants; steel mills; metal fabricating plants; foundries; paper mill and product plants; petroleum refineries; food processing plants; rubber mills and textile mills. (New York, Clapp and Poliak, 1957. 273p., $10.00.)

°DIE TRANSFORMATION, 3RD ED.

A comprehensive treatise on the theoretical and practical aspects of large power transformers. Major headings are as follows: general characteristics of transformers; design of the transformer; the three-phase transformer; heat transfer during operation; the iron core, no-load operation, and switching surges; the windings; boundary problems in transformer design; practical examples of transformers. Completely revised, after 30 years, on the basis of the author's extensive experience in the field. (By M. Vidmar. Basel, Birkhauser, 1956. 630p., 68.00 Swiss Francs.)

TECHNICAL BULLETINS AND PAMPHLETS RECEIVED

Aerial Survey

Photogrammetry and aerial surveys; a symposium (U.S. Highway Research Board Bulletin 157)

Atomic Energy

The Financial Times annual review of British industry in this atomic age, 1957.

Concrete

Loading tests on a large reinforced concrete slab spanning in one direction. A. J. Ockleston. (The Concrete Association, tests on the Old Dental Hospital, Johannesburg; paper no. 5)

Electrochemistry

Electro-precipitation. R. F. Heinrich and J. R. Anderson. London, Butterworth, 1957. (Reprint from Chemical Engineering Practice)

Industrial Relations

Personnel management and the professional employee (Princeton Univ., Industrial Relations Section; selected references, no. 76)

Petroleum

A survey of the natural gas industry in Canada during 1956. R. B. Toombs and R. A. Simpson. (Canada. Dept. of Mines and Technical Surveys. Mineral resources circular 24)

A survey of the petroleum industry in Canada during 1956. R. B. Toombs and R. A. Simpson. (Canada. Dept. of Mines and Technical Surveys. Mineral resources circular 23)

Rubber

Natural Rubber Development Board Annual report for 1956.

Rubber Technical Developments Ltd. Annual report for 1956.

St. Lawrence Seaway

The St. Lawrence Seaway Authority. Annual report for the fiscal year ended December 31, 1956.

International Geophysical Year

The International Geophysical Year. W. J. Mackey. (Reprint from Canadian Geographical Journal.)

The International Geophysical Year; a twentieth century achievement in international cooperation. (Reprint from U.S. Department of State Bulletin)

Town Planning

New towns. Z. Przgoda, 57 Queen St. W., Toronto. $1.00.

STANDARDS RECEIVED

A.S.T.M. Standards, American Society for Testing Materials, 1916 Race St., Philadelphia 3.

Bituminous materials for highway construction, waterproofing, and roofing (with related information) 448p., $4.75.

Rubber products (with related information) 826p., $7.00.

Thermal insulating materials (with related information) 208p., $3.00

British Standards, British Standards Institution, 2 Park St., London, W.1. Also available from the Canadian Standards Association.

B.S. 2856:1957. Precise conversion of inch & metric sizes on engineering drawings.

Canadian Standards, Canadian Standards Association, National Research Building, Ottawa.

Canadian Electrical Code: Part 2 C22.2 No. 1-1957, Construction and test of power operated radio devices.

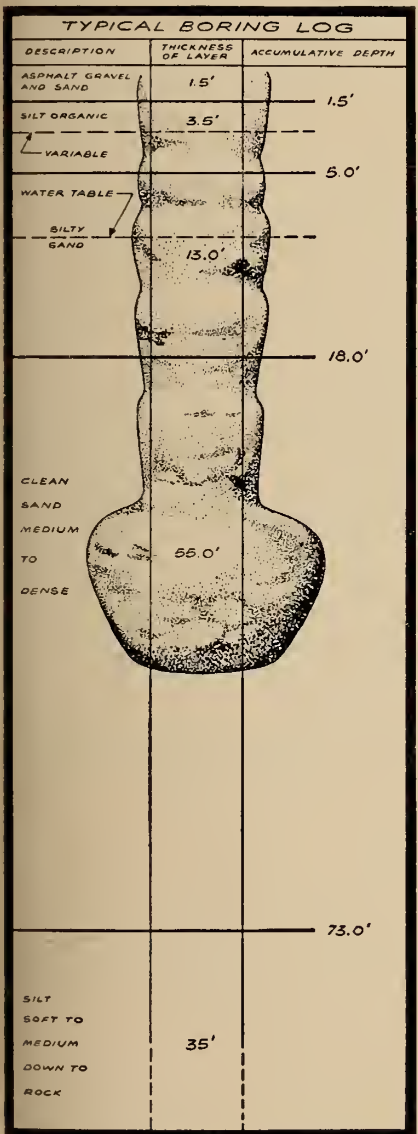
C22.2 No. 54-1957, Construction and test of integral-horsepower electric motors for other than hazardous locations.

C22.2 No. 108-1957, Construction and test of electric water-pumps for other than hazardous locations.

C22.2 No. 112-1957, Construction and test of domestic clothes-drying machines.

Aluminum Association, 420 Lexington Ave., New York 17.

Drafting standards aluminum extruded and tubular products, 3rd ed. 1957.



The site of the new Canadian Pacific Airlines Hangar, Vancouver Airport. At left, a standard FRANKI reinforced displacement caisson undergoes a 180-ton test load. The top of another FRANKI caisson appears in the foreground. At far right, a FRANKI rig drives another displacement caisson.

Franki displacement caissons support C.P.A. hangar, Vancouver Airport

A brief study of the conditions to be met by the Designer of the foundations on this job revealed the following requirements:

(a) Hailed as the largest hangar of this type ever built for Canadian Civil Aviation, the loads on the foundations were therefore considerable.

(b) Considerable uplift loads in this type of structure had to be taken care of.

(c) The high but variable water table increased the risk of settlement if friction piles were used and brought up the risk of rotting of timber piles if the latter were employed.

(d) Soil conditions required that the loads be carried into the competent sand stratum overlying the lower silts, but with penetration of piles kept as high as possible above the silts, to avoid consolidation and settlement.

By choosing FRANKI DISPLACEMENT CAISSONS . . .

(a) A guaranteed working load of 100 tons per caisson was provided, decreasing cost by lowering the number of piles required, and by reducing sizes of caps, excavation, etc.

(b) Uplift capacity of 2½ to 1 as compared with timber piles.

(c) End bearing was ensured, with each individual caisson immune to the effects of variations in the water table evaluation.

(d) Penetrations were kept to a high elevation, the average depth of caisson bases being only one foot below the minimum depth specified by the designer.

A 180-ton load test, twice the design load, gave a gross settlement of 0.31 inches, and a net settlement of 0.08 inches. A combined compression-traction test gave the following results:

1 Caisson in Compression	Max. Load 121 Tons	Net Settlement 0.001"
2 Caissons in Traction	Max. Load on Each 35 Tons	Net Uplift Nil

The job was completed on schedule, to the great satisfaction of all concerned.

JOB DATA:

Client: Canadian Pacific Airlines
Consulting Engineer: O. Safir, Vancouver
General Contractor: Marwell Manitoba Ltd.
Number of FRANKI CAISSONS: 210 (174 at 25° batter)
Design Load: 90 tons per Caisson
Average Length of Caissons: 31 feet
Soil Investigation: Boyles Bros. Drilling Co. Ltd., Vancouver
Soil Report: Ripley & Associates, Vancouver

THE FRANKI CAISSON is a pressure injected footing, with an expanded base forged by blows of 150,000 ft.-lbs. of energy. In granular soils, the standard Franki caisson will carry a load of 120 tons or more.

LITERATURE on the various Franki methods of foundation and regular mailings of "Franki Facts" about job highlights, will be sent upon request. Write: Franki of Canada Ltd., 187 Graham Blvd., Montreal 16, P.Q.

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Calendar

(*Continued from page 1542*)

Nuclear Congress

The Nuclear Engineering and Science Conference Committee (Program Steering Committee) met in July to review subject areas planned for the technical program of the 1958 Nuclear Congress and decided upon the following principal areas:

A. Radioisotope Utilization 1. Biological uses, 2. Product and Process Control, 3. Tracer Applications, 4. Production and Distribution 5. Gamma Ray Heating;

B. Reactors As a Source of Process Heat;

C. Radiation – Induced Chemical Reactions;

D. Standardization, Codes and Licensing: 1. Process, 2. Equipment, 3. Overall Design, 4. Licensing, 5. Inspection;

E. Plant Location and safeguards: 1. Handling and Storage Problems, 2. Biological Tolerance, 3. Plant Design Evaluation, 4. Availability and Contamination of Water Supply, 5. Waste Disposal, 6. Atmospheric Control, 7. Site Evaluation;

F. Reactor Operation and Maintenance;

G. Progress in Commercial Power Reactor Development;

H. Reactor Engineering; 1. Component Development, 2. Thermal and Mechanical Design, including Heat Transfer, 3. Systems Analysis, 4. Fuel Element Design and Fabrication, 5. Instrumentation and Control, 6. Containment and Shielding.

I. Reactor Fuel and Control Materials: 1. Preparation, 2. Properties, 3. Reprocessing;

J. Reactor Plant Materials;

K. Experimental Reactors and Critical Assemblies.

The Engineering Institute of Canada is one of the thirty societies sponsoring the Nuclear Congress, 1958.

Concrete Products

The next annual convention of the National Concrete Products Association will be held in Ottawa at the Chateau Laurier Hotel, January 16, 17, 18, 1958.

Information can be obtained from the Presentation of Canada Limited, 143 Yonge St., Toronto 1, Ont.

Construction

The calendar of the Canadian Construction Association (Construction House, 151 O'Conner St., Ottawa, Ont.) is as follows:

Executive and management committee December 1-2, Seigniory Club, Montebello, Que.

The fortieth annual meeting of C.C.A. will be at the Chateau Frontenac, Quebec City, from January 26 to January 29, 1958.

Canadian Technical Committee

The first Canadian technical committee in the National Association of Corrosion Engineers has been formed under the chairmanship of C. L. Roach, Bell Telephone Company of Canada, Montreal. The task of the committee is to co-ordinate activities of local electrolysis organizations.

Chemical Engineering

The annual meeting of the American Institute of Chemical Engineers, 925 West 45th St., New York 36, N.Y. will be at the Conrad Hilton Hotel, Chicago, Ill., December 8-11, 1957.

Operations Research

The twelfth national meeting of the Operations Research Society of America, a two-day program, is scheduled for November 14-15, 1957, at the Penn-Sheraton Hotel, Pittsburgh, Pa.

Wave Research

The Council on Wave Research announces the Sixth International Conference on Coastal Engineering, to take place in Florida, December 2-7, 1957.

Further information on the Conference can be obtained from Prof. J. W. Johnson, 200 Mechanics Building, University of California, Berkeley 4, Calif.; or Dr. Per Bruun, Coastal Engineering Laboratory, University of Florida, Gainesville, Florida.

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CANADIAN DEVELOPMENTS

(Continued from page 1489)

The Canadian Forest

Management for full production will pay equal attention to the growth of timber products from all accessible areas, and to production of fish and game, healthful recreation and opportunities for enjoyment by all Canadians. The Canadian forest is capable of producing all this, permanently and profitably.

Surpassed only by the pine and spruce forests of the Soviet Republic a similar latitudes in Europe and Asia, the forests of Canada with an annual output of over 6½ billion board feet of lumber and other sawn products comprise one of the most extensive areas of softwood timber in the world. These were statements of the general manager of the Canadian Forestry Association, J. L. Van Camp, in an address to the Audubon Society for Canada.

Title to the bulk of Canadian forest is vested in the Crown; most commercial saw milling, the cutting of trees for pulp and paper production, and many other forest industries, are operations by private companies under lease or licence on Crown lands. They are subject to regulations which maintain a continuous wood, water and game producing resource in which new crops are obtained automatically by logging practices which help nature produce the new crops.

Another very necessary measure in the control of the forest, fundamentally educational, is that of improving the public attitude toward the forest.

In its work of education, Canadian Forestry Association lecturers have travelled in forest areas by motor car with motion picture films, books, bulletins and kodachrome slides on forest conservation. Both major railways have contributed railway coaches, used as moveable auditoriums for conservation lectures, on all lines in the nine provinces.

In its tremendous output of lumber and other sawn products, British Columbia, with Douglas fir, hemlock on the coast, pine and spruce in the interior, produces timber of large size and high quality. Saw milling is important across the northern two-thirds of the central western provinces. Northern Ontario, Quebec and the maritime provinces contribute heavily to sawn-timber production,

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Resists corrosion by hot sulphuric, sulphurous and phosphoric acid solutions. Also resists nitric acid solutions, nitrates, cupric, ferric and mercuric salts except chlorides. Considerably better resistance than stainless steels to pitting by sea water or stress corrosion cracking in chloride solutions.

These high Inco Nickel Alloys provide exceptionally good performance characteristics, particularly where extreme heat or highly corrosive conditions are a factor. In many applications they will long outlast competitive materials. The alloys shown here are available in most standard forms . . . and Inco Customer Service goes with them . . . to help you solve metal problems. Write us for complete information.

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and all regions produce other rough primary forest products.

In fact, Mr. Van Camp added, since the mid-twenties, the rise of the pulp and paper industry has been the greatest single factor in the Canadian forest industry.

Steadily growing demands create increasing production of lumber, pulp and paper products. This constant expansion causes public apprehension regarding the depletion of the forest resource. In general there is no cause for alarm from expanding forest industry in Canada over the next 25 years. However, this does not imply that completely satisfactory conditions are present in every part of the Canadian forest. On some privately-owned lands the most destructive practices, and the poorest quality of management are found. The development of a complete all-year system of roads, permitting frequent return to areas for timber cuts at short intervals, and permitting better fire and insect protection practices will improve over all forest management and forest production.

Estimating that Canadians will need 28 million cords of pulpwood twenty-five years from now, Mr. Van Camp added that through the technical abilities of mills to use species formerly considered useless, such trees as the aspen poplar, can now be utilized. In quantity this timber equals all other hardwood species combined. Long range economics make it advisable to undertake these investments, and they are already being financed by several companies. Waste has also been greatly avoided. The decreased use of wood for fuel and the increased demand for pulpwood products has revolutionized the situation.

Forest recreation is important to Canadians and their tourist visitors. Also coming to public attention are the very essential water resource values provided by forest cover, combined with good agricultural management of land. The intimate relation between the amount of water available to a territory and the management of forest and agricultural cover upstream is only now coming to the critical attention of governments and the general public.

Pulp Mill in Nova Scotia

The Nova Scotia government announced in July that it had entered into an agreement with a new company, Nova Scotia Pulp Limited which, it is almost certain, will provide a $40 million pulp mill in Eastern Nova Scotia. Preliminary engineering studies indicated a site on the Strait of Canso.

The proposed mill would be one of the largest and most modern in Canada, with a producing capacity in excess of 300 tons per day of high quality bleached pulp, and an expenditure of $10 million annually for wages and purchases.

Nova Scotia Pulp Limited, the premier said, is not a subsidiary of any company, but it has an agreement for technical advice with Stora Kopparbergs, a Swedish company, and for the use of patented methods.

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CANADIAN DEVELOPMENTS

The government of Nova Scotia has to approve control of the company until such time as it is finally launched. Two company officers were mentioned in later news items, as follows: president, Carl A. Clauson, of Kopparbergs' U.S. operations, and secretary, A. Gordon Cooper, of Halifax.

Cutting will be done under a controlled forest management plan. Wood requirements for the mill would be 250,000 cords annually; the company would cut 150,000 cords from its licensed lands and would purchase a further 100,000 cords from private lumber operators and owners in the province. It would also use 25,000 cords per year of hardwoods.

What Goes On

Control of Dosco

A. V. Roe Canada sought control of the Dominion Steel and Coal Corporation with an offer to Dosco shareholders of one and a quarter of its shares plus $10.25 cash for each Dosco share. The offer was contingent on acquisition of 52 per cent, and was open until October 1.

Dosco directors were divided in their reactions to the offer. However, the view of the majority of directors was given by President Lang in a letter to the shareholders, in which he said the advantages to Dosco were judged to be such that these directors had accepted the offer and were depositing their Dosco holdings with A. V. Roe.

At the October 1 deadline A. V. Roe claimed to have effective control with 40 per cent, and expected shortly to have 52 per cent of Dosco stock.

Ventures Ltd.

John D. Barrington is the new president and managing director of Ventures Ltd., one of the world's largest mining organizations, based in Toronto. He is the former president of Polymer Corporation, Sarnia, and remains a director of Polymer. *Financial Post, Sept. 28.*

Shawinigan Water and Power

Plans by the Shawinigan Water and Power Company to undertake

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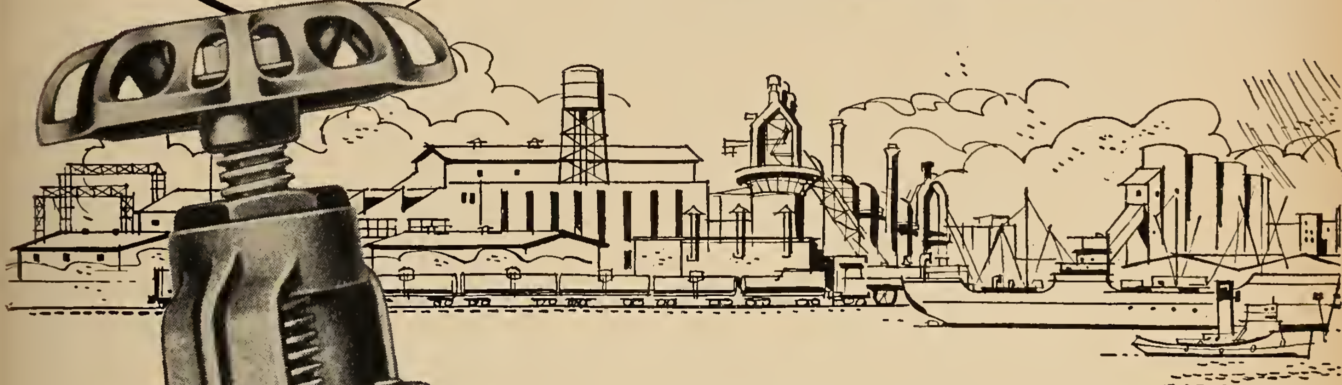

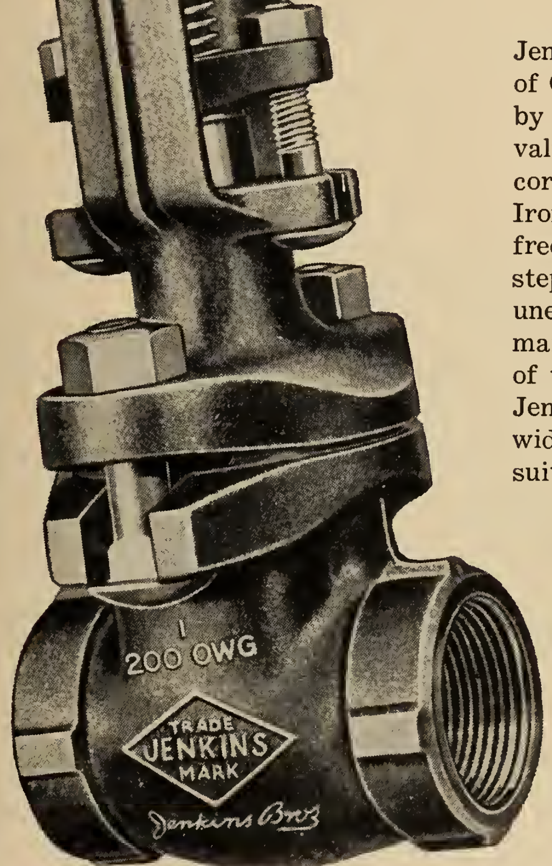

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additional financing were made known in September.

President J. A. Fuller noted that in view of the Company's recent and prospective rate of growth, it is considered desirable to provide a broader basis of financing.

Atomic Energy of Canada Limited

The price of cobalt 60 has been sharply reduced by both atomic Energy of Canada Limited and the U.S. AEC, it was announced in August.

It is expected that lower prices will encourage more widespread industrial, medical and research use of the powerful gamma emitting isotope.

Uranium in Saskatchewan

Lorado Uranium Mines' $9.2 million mill was in full operation in August in the Beaverlodge area of Saskatchewan. Eldorado and Gunnar have respectively 2000 and 1800 ton capacity mills already operating in this field. Lorado will increase its mill capacity from 500 to 700 tons during the next year.

Nova Scotia Power

A new hydro plant was set in operation recently, completing the second step in development of the east branch of Bear River in Annapolis County, N.S. It will have an estimated capacity of 12,000,000 kw.h. annually and will bring the total annual capacity of the Bear River development to 32 million kilowatt-hours.

The Premier of Nova Scotia, Hon. Robert L. Stanfield, said on this occasion that there has been a steady growth in power consumption in Nova Scotia amounting to nine per cent each year. The bulk of the province's expansion would be accomplished in the future through thermally operated stations, he said.

B-A Refinery in B.C.

At Port Moody, B.C., site of the British American Oil Company Limited's new 20,000 B.p.d. refinery, the 400 acre plot is being made ready for construction.

The refinery is scheduled for completion by late 1958. Canadian Kellogg will complete the engineering and construction of topping, vacuum, catalytic reforming, hydro-desulphurization, alkylation and catalytic cracker units.

Albertans Receive Dividend

The first Oil and Gas Citizens Royalty Dividend — $20 — is available to approximately 550,000 eligible Albertans since September and until December 31.

Dividends are payable from an $11 million fund set up under the Oil and Gas Royalties Dividend Act.

Northland Development Study

The Alberta Government recently appointed a three-man commission to make a comprehensive study of the development potential of Alberta's northland. Chairman of the commission is J. G. MacGregor, chairman of the Alberta Power Commission; members are Roy C. Marler, past president of the Alberta Federation of Agriculture, and J. O. Patterson, of Grande Prairie.

All sections of the province north of the 55th parallel will be included in the investigation, which will determine the extent and location of na-

tural resources, and likely areas of population concentration, agricultural and industrial opportunity, transportation and communication requirements, electrical power resources and requirements, market trends, and methods to assist general development.

Computer Installation

Adalia Computations Limited, Montreal, have installed a computer, of the Datatron System type to be available to business, industry, government, universities, research establishments, etc., on rental basis. A staff of problem analysts, programmers, mathematicians and engineers has been trained for problem preparation and for operating the computer.

The Datatron System has automatic floating point facility and high speed input-output units — adaptable to engineering design calculations as well as business data processing applications, it is reported.

Gas Processing Plant

A $20,000,000 plant to be in operation by September 1958, for gathering, processing and transmission of casinhead gas in the Steelman area of south-eastern Sakatchewan is to be constructed by Steelman Gas Limited, formerly Provo (Sask) Ltd. The wasted gas, now being flared in excess of 1,000,000 cubic feet per day will be processed into propane, butane, gasoline, sulphur and dry residue gas. The latter is to be sold to the Saskatchewan Power Corporation for use in its natural gas distribution system.

Selection and Training of Second Line Executives

(Continued from page 1472)

adequacy of the "one course per man" form of training.

After a very constructive discussion on the means of selection, the chairman summed up the views of the panelists as follows:

1. The oustanding qualities looked for in the potential general manager are leadership and initiative.
2. Training for management has to be considered and provided for throughout the individual's career. It is necessary to watch constantly the man's progress, and the right kind of appraisal form and training program play important parts in this respect.
3. It is necessary both for the company to assist the individual and the individual to assist himself in the matter of management training.
4. In selecting men for promotion, as many means of appraising and assessing the individual by as many assessors as possible is a golden rule. The difficulty is to avoid personal bias and to find an adequate yardstick.

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Treasurer—O. M. Solandt
General Secretary—L. Austin Wright

(*A complete list of Officers is in the issue of October,* 1957)

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Contents - November 1957

(18,950 copies of this issue printed)

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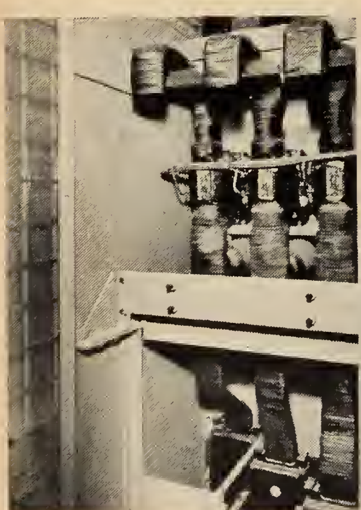

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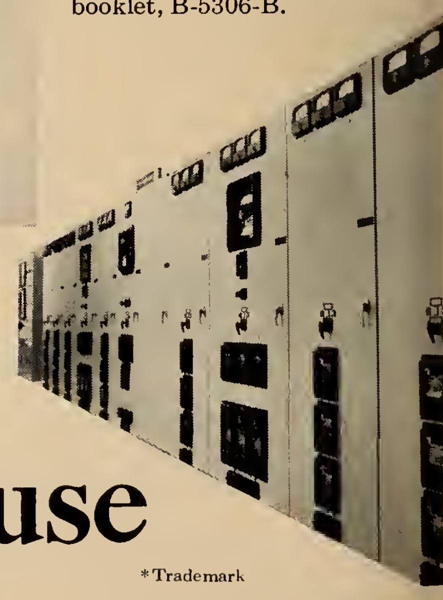

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The Peace River and Alaska Highway Gas Gathering System

A. L. Berry, M.E.I.C.
Principal Pipeline Engineer, Westcoast Transmission Company Limited.

B. L. Moreau, JR. E.I.C.
Production Engineer, Pacific Petroleums Limited.

Paper presented at the Annual General and Professonal Meeting of The Engineering Institute of Canada, Banff, Alberta, June, 1957, in cooperation with The Petroleum Division, American Society of Mechanical Engineers.

ONE OF CANADA'S most extensive natural gas gathering systems is rapidly nearing completion. The system is designed to fill the requirements of the Westcoast Transmission Company's 650 mile long 30-inch diameter pipeline originating at Taylor, British Columbia, where the Alaska Highway crosses the Peace River; terminating at Huntingdon on the International Boundary just east of Vancouver.

In addition to its 30-inch transmission line Westcoast Transmission Company is constructing approximately 130 miles of main gathering lines ranging in sizes from 12 to 26 inches; the producers, primarily Pacific Petroleums Limited and Associates, in the seven major gas fields to be connected initially are constructing 80 miles of field gathering lines ranging in sizes from 4 to 12 inch. The gathering system will have an initial capacity of 400 million cubic feet per day, to match the initial designed capacity of the Westcoast Transmission line, and will be capable of expansion as additional gas is required. The overall cost of the project will approach $200,000,000 including main transmission lines, processing and gathering facilities.

Approximately 25 per cent of the initial throughput will be required for sales in the Caribou, Okanagan and Kootenay areas and in the lower Fraser district and City of Vancouver. The remaining 75 per cent of the initial throughput will be delivered at Sumas, Washington, across the border from Huntingdon, B.C., for transmission to the Northwestern United States.

Figure 1 shows the route of the transmission line with its four compressor stations spaced approximately 150 miles apart, the connecting sales lines, and the gathering system area. Figure 2 shows the gathering system extending southeast to the Peace River area of Northwestern Alberta and northwest along the Alaska Highway tapping one of the largest potential gas-producing areas in Canada served by one pipeline. No unusual pipeline construction problems are anticipated since the route is almost completely free of rock and muskeg, through rolling terrain varying from open farm land to moderately heavy timber.

The extensive gas gathering system to serve Westcoast Transmission Company Limited is nearing completion. The system is described in this paper and the gas handling facilities between the wellhead and treating plant are discussed. Two-phase flow is used in part of the gathering system, and the paper outlines an empirical method of predicting pressure drop in gas-condensate pipelines.

The southeastern extension is a dry sweet gas gathering system of conventional design whereas the northwestern extension is essentially a wet sour gas gathering system with many new and interesting features.

Dry Sweet Gathering System in Alberta

The Alberta production to be connected initially is primarily Cretaceous at shallow depths from 1200 feet to 4500 feet and is essentially sweet and dry at moderate reservoir pressures. The gas requires only the removal of water vapour to meet pipeline specifications since the gas is lean enough not to require any hydrocarbon dewpoint control. The water will be removed at each well in a glycol dehydration unit consisting of a triethelyne glycol absorbing tower, glycol pump and regenerator. Glycol dehydrators were chosen in preference to other types of equipment such as calcium chloride and dry desiccant units after consideration of initial cost, operating cost, and ease of operation. The rather low flowing temperatures of the wells allows dehydration of the gas to a zero degree dewpoint in a suitably designed triethylene glycol dehydrator. Particular attention was given to making the units operative in subzero weather. Regenerator still columns will be insulated to prevent excessive reflux, which tends to flood still columns in cold weather. Internal venting of the still overhead down through the still column will result in a higher exit temperature of the overhead stream, and less likelihood of freezing. All absorber towers will be equipped with integral scrubbers in the base of the towers. Hot lean glycol will be circulated through coils in the base of the scrubbers to prevent freezing. All units are housed to reduce heat loss, and mechanical controls are used wherever possible rather than gas operated bleed pilot controls which have a tendency to freeze off at the low ambient tem-

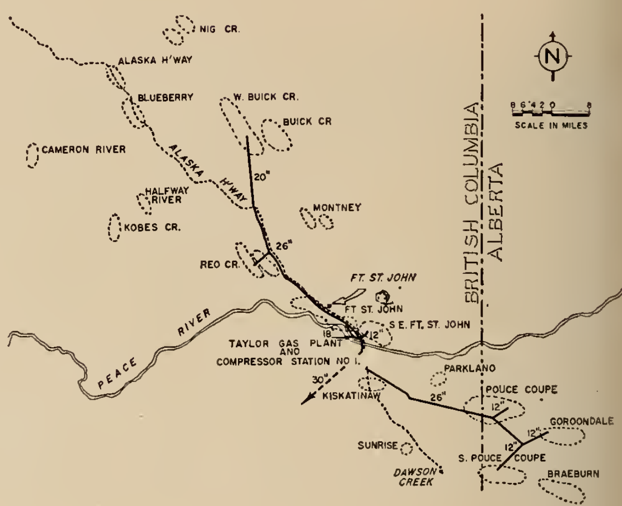


Fig. 1. (above), Westcoast transmission system. Fig. 2 (right), a diagram of the gas gathering system.

peratures to be encountered. All wells will be equipped with a flow control so that a drop in gathering system pressure results in increased production from each well up to a pre-set maximum determined individually for all wells. In this way an operator at a central point will be able to control the field production. Gas will be metered at the outlet of each wellhead absorber tower in accordance with production regulations using the dry bellows type of recording orifice meter. At the field gate station near a central point in the field the gas will be measured again and the back pressure in the field gathering system will be controlled before it enters the purchaser's system. The gas will be metered at the Alberta border before entering B.C. in order to determine Provincial export volumes. The main gathering line from Alberta being constructed this year is 26 inches in diameter, to handle 130 million cubic feet per day, with additional capacity for future extensions. The formation pressures are such that this gas will require compression at Westcoast's Number 1 compressor station at Taylor, B.C., on the inlet to the 30-inch transmission line, operating initially at approximately 865 p.s.i.g. An interesting feature of this 26-inch southeast extension is the suspension bridge crossing of the Peace River, which carries both the 26-inch gathering line with gas flowing north to the Number 1 compressor station, and the main 30-inch transmission line with gas flowing south. The span is 1675 feet, which is approximately 125 feet greater than the span of the Lions Gate bridge in Vancouver. It was desirable to locate the compressor station on the north side of the Peace River adjacent to the Taylor gas treating plant to simplify operations, necessitating this dual crossing 26-inch and 30-inch with gas flowing in opposite directions.

Wet Sour Gathering System in British Columbia

The northeastern B.C. gas production is primarily from deeper high pressure formations, Lower Cretaceous, Jurassic, Triassic, Permo Pennsylvanian, and Mississippian, from 3000 feet to 7500 feet, and it contains liquid hydrocarbons and hydrogen sulphide. To prevent hydrate formation in the well tubing at temperatures as high as 70° F., bottom hole diethylene glycol injection will be used in most cases. The glycol injected removes water vapour in the gas stream by means of co-current absorption as the glycol is returned to the surface. The wells produce retrograde condensate at the rate of 3 to 30 barrels per million cubic feet of gas. Since the condensate will be in contact with the glycol in the tubing, it will be dehydrated for pipeline transmission in the same manner as the gas stream. The glycol-water mixture will be separated from the gas and condensate in a three-phase separator at the surface (three-phase meaning first, glycol-water mixture; second, condensate; and third, gas phase). The gas and condensate will then be re-combined for transportation in a two-phase gathering system. The glycol will be regenerated in the same type of glycol regenerator as used in the sweet dry gas fields and will then be reinjected at the bottom of the tubing string. The wells will be equipped with a pressure control to reduce the flowing wellhead pressure to gathering system pressure. As in the dry gas systems, the producers will install wellhead flow controls so that a drop in gathering system pressure results in increased production from each well up to a pre-set maximum determined individually for all wells. The wells will also be equipped with an over and under pressure shut off of a high-pressure balanced diaphragm design believed most suitable for cold weather operation. Since this so-called wet sour gas contains considerable amounts of hydrogen sulphide and carbon dioxide, a corrosion inspection and control program will be instigated. Corrosion control will be accomplished by adding a liquid semi-polar organic corrosion inhibitor to the glycol to protect the well equipment, and also to the condensate on the downstream side of the wellhead separators to protect the gathering system.

This wet sour gas will be brought to the Taylor gas treating plant now under construction on the same site as the Number 1 compressor station. The Taylor plant is essentially an amine scrubbing plant for removing the acid gas, an absorption plant for recovering propane, butane and natural gasoline and a dry desiccant dehydration plant for drying the gas after treating. The location of this plant on the banks of the Peace River was determined by the need for large quantities of water for cooling and for steam generation, amounting to approximately 42 million gallons per day. By way of comparison, this quantity of water would serve the maximum day requirements of a city with a population of over 200,000. The hydrogen sulphide gas from the scrubbing operation will be delivered to a sulphur recovery plant, which will process initially some 300 tons per day of elemental sulphur. The liquid products will be delivered to a processing plant also at this location, where they will be upgraded to make saleable products.

This wet gas gathering system, consisting of a 12-inch line to South East Ft. St. John field, an 18-inch line to Ft. St. John field and a 26-inch line northwest along the Alaska Highway, connected to a 20-inch line to the West Buick Creek field, will be called on to transport approximately 300 million cubic feet per day of raw gas, plus several thousand barrels per day of liquid hydrocarbons. Each line ends at the Taylor plant in large inlet scrubbers designed to remove liquids efficiently at very high rates, which leads us to the matter of two-phase flow in this portion of the gathering system.

Two-Phase Flow

It is commonly recognized that the transmission pressure drops in a horizontal two-phase "gas-condensate" pipeline are greater than in a dry gas line and that even relatively small amounts of liquid have a considerable effect. The factors contributing to this additional pressure drop are as follows:

(i) Energy lost by the gas in accelerating and transporting the liquid.

(ii) Increased roughness caused by wetting the pipe wall and by waves on the surface of the liquid.

(iii) Reduction in available flow area caused by the introduction of a liquid phase.

Pressure drops in the northeastern B.C. system are expected to be

Top to bottom: Laying pipe for the gas gathering system; welding the gas pipeline; a general view of the refinery at Taylor, B.C.

higher because in hilly terrain additional energy is lost by the gas in lifting the liquid over every individual rise. This additional pressure drop appears to be dependent, to a very large degree, on the gas velocity in the pipeline.

There are six main types of flow patterns which have been recognized in two phase flow. The various flow patterns are shown in Figure 3. Assuming a horizontal pipe running full of liquid flowing initially so as to completely fill the pipe, and considering the effect of adding increasing volumes of gas, the type of flow to be anticipated is as follows:

(1) *Bubble Flow*—in which separate bubbles of gas travel along the upper part of the pipe at approximately the same velocity as the liquid.

(2) *Stratified Flow*—in which the liquid flows along the bottom of the pipe and gas flows above with a relatively smooth interface.

(3) *Wave Flow*—which is similar to stratified flow except that the gas moves at a higher velocity and the interface is disturbed by a wave action.

(4) *Slugging Flow*—in which the interface level rises and falls and frothy slugs are formed periodically and pass along the pipe at higher velocities than the average liquid velocity.

(5) *Annular Flow*—in which the liquid flows in a uniform film on the pipe wall and gas travels at a high velocity through the central core.

(6) *Fog Flow*—in which most of the liquid is entrained as fog or spray by the gas at extremely high gas velocity. Sometimes called "dispersed flow".

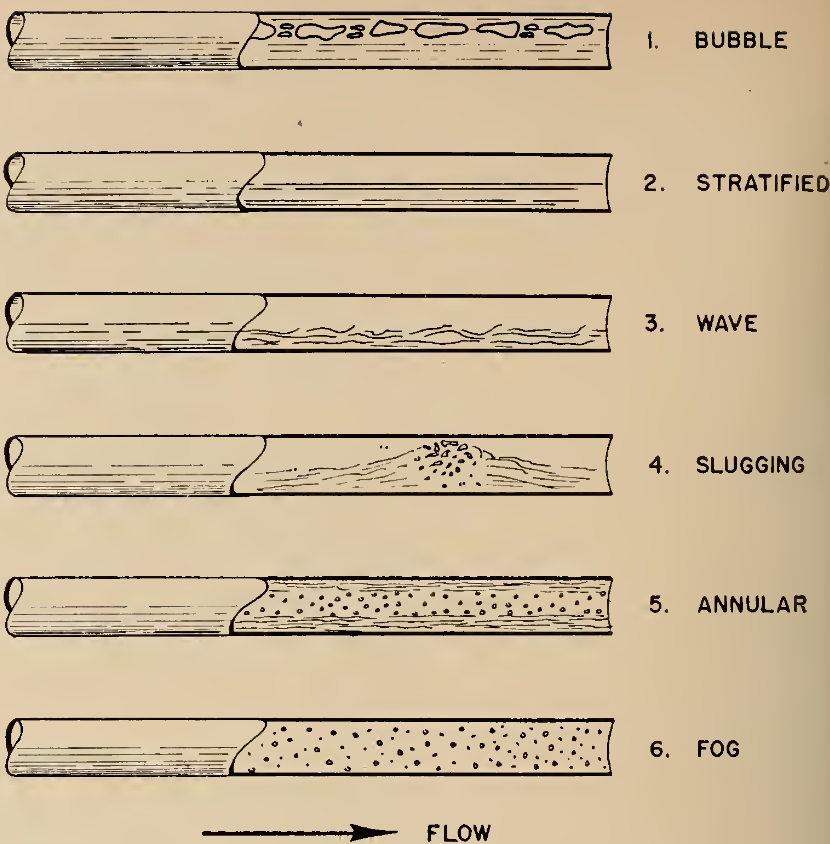
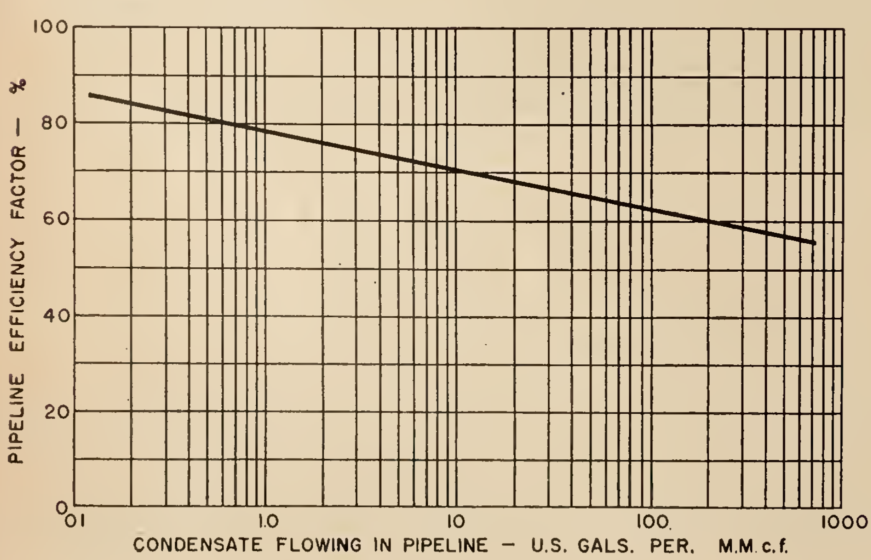


Fig. 3. Flow pattern sketches: horizontal two-phase pipeline.

Stratified and wave types of flow patterns are expected initially in the B.C. gathering system.

Limited published data are available on two-phase pipelines operating at high pressures and most of these data are for practically horizontal lines. However, a study of operating data available on 4 inch to 16 inch high pressure two-phase pipelines, operating in Canada and the United States under somewhat similar conditions to those anticipated, suggested an empirical approach to this problem of determining total pressure drop in the B.C. gathering system, which is through predominantly rolling terrain.

Fig. 4. Reduction in pipeline efficiency factor as rate of condensate flow in horizontal pipeline is increased.



The pressure drop in a two-phase line is calculated in two steps. Figure 4 shows the effect of increasing amounts of condensate on the Panhandle eastern flow formula efficiency factor. It can be noted from this curve that even relatively small amounts of liquid which barely wet the wall of the pipe depress the efficiency factor to a considerable extent. This reduction in flow efficiency is for a horizontal line under stable flowing conditions. The amount of liquid in the line at flowing temperature and pressure is determined from test, or by flash calculation based on a knowledge of the composition of the gas. Ground temperatures are important since they affect the amount of hydrocarbons in the liquid phase. A survey of ground temperatures in the area indicated that the gas temperature in a pipeline buried 3½ feet below the surface does not fall below 25° to 30° F. during the winter months, even

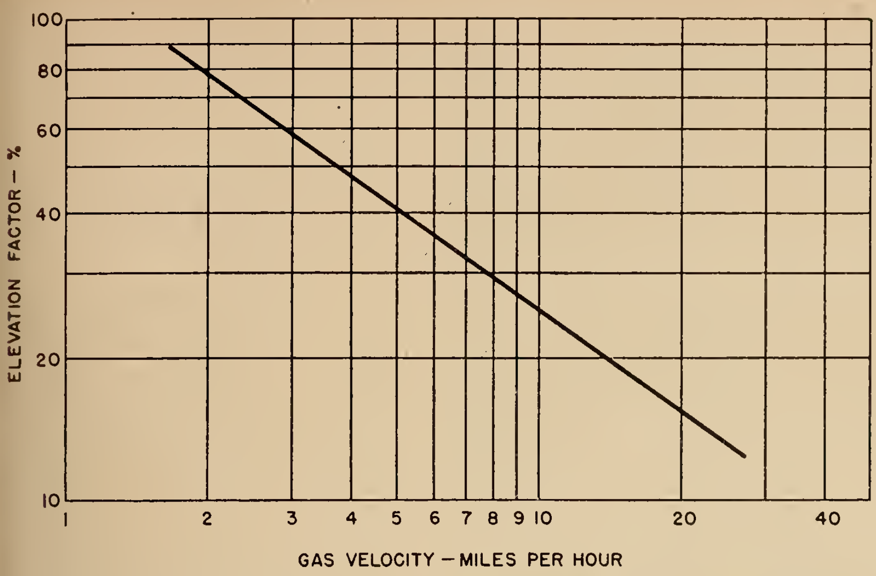


Fig. 5. Illustrating reduction in elevation factor as gas velocity is increased.

though the frost line may reach 8 to 10 feet.

Figure 5 illustrates the effect of gas velocity on elevation factor. The elevation factor can be defined as the percentage of total liquid head that appears as pressure drop over the line. The liquid head calculated from an accurate profile of the line is not the net change in elevation between the two ends of the line, but rather the sum of all the vertical rises. The specific gravity of the liquid used in determining the total head on the line is determined by test or by flash calculation. The percentage of the liquid head then which will appear as pressure drop, is a function of the gas velocity in the line and total pressure drop expected will be the sum of the pressure drop calculated for a horizontal line, plus that due to liquid head.

The type of result to be expected is illustrated in Figure 6. An optimum flow is indicated for each size of line, assuming that stable flow conditions are allowed to develop. The optimum line size for any particular quantity of gas and liquid to be transported will depend on the vertical profile of the line.

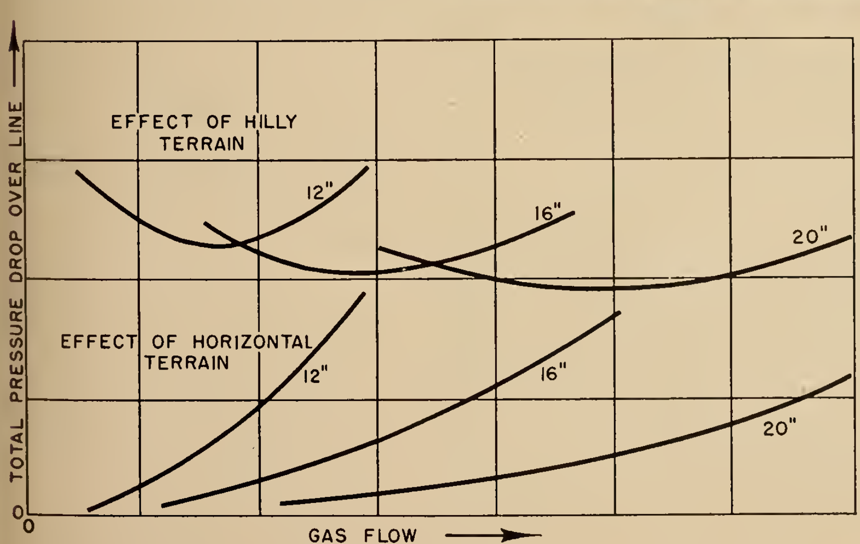
This approach also indicates that total pressure drop in a two-phase line is not always reduced by increasing the line size. This becomes more apparent as the total of all the rises on the system becomes greater.

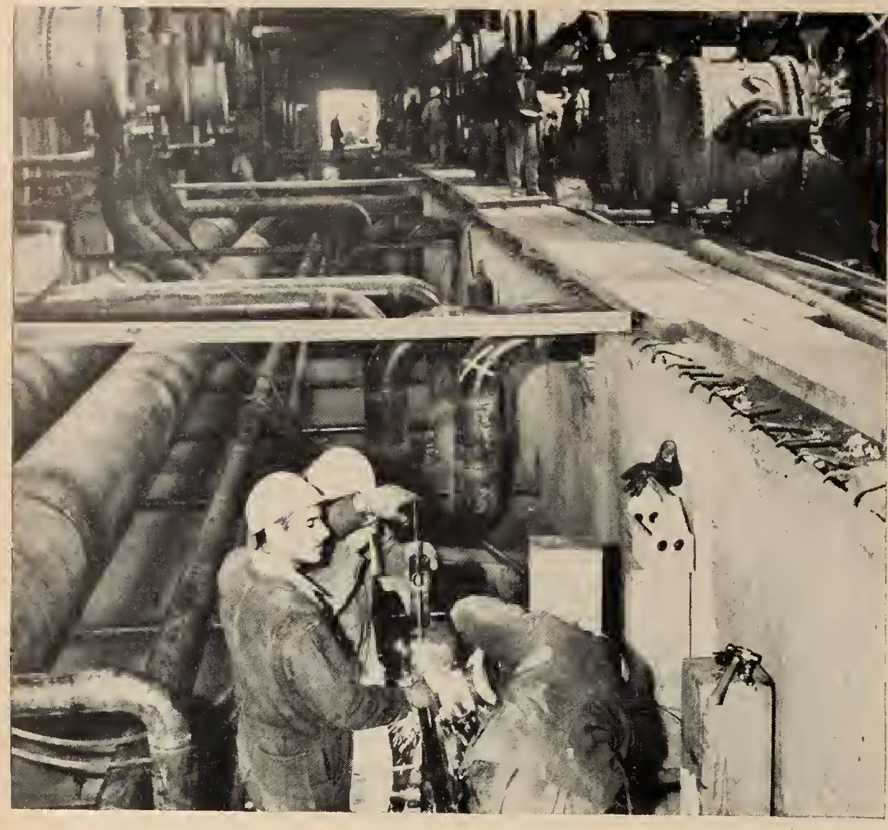
Although this approach to the matter of two-phase pressure drop in a "gas-condensate" system is empirical, and more field test data would be desirable, it is of considerable value in selecting the line size and in predicting the total pressure drop, especially where the largest portion of the total pressure drop is due to the effect of terrain and pipeline velocities do not exceed 10 miles per hour.

The provision of a separate liquid line parallel to the longer main gathering lines would provide extra gas-carrying capacity for future expansion with a minimum of compressor horsepower. The liquid would be removed at the various points where the gas flowing in the line had

Stringing pipe for the Shelley Crossing of the Fraser River.

Fig. 6. Illustrative example of the effect of hilly terrain in two-phase flow.





Welders at work during the construction of the refinery at Taylor, B.C.

reached ground temperature, where no further liquid condensation would be expected. A back pressure would of necessity be maintained on the separate liquid line in order to achieve minimum pressure drops by preventing flashing of the liquid.

Since the elevation effect on some lines can be quite severe, extra grading and spanning can be justified. Line location to avoid extreme elevation changes is a very practical approach to reducing operating costs by reducing total pressure drop.

Communications

The communication system for the gathering lines will be an extension of the main pipeline VHF radio system.

A 50 watt VHF base station, operating in the 152-174 megacycle band, will be situated at Charlie Lake, about five miles northwest of Ft. St. John, with a directional antenna beaming the signal toward the Buick Creek fields. Another 50-watt VHF base station will be installed at Bessborough, near Dawson Creek, with a directional antenna beaming the signal towards the Pouce Coupe, South Pouce Coupe, and Gordondale fields. These two base stations will be remotely controlled simultaneously by the gathering system dispatcher at Fort St. John.

All maintenance vehicles of the Transmission Company will be equipped with 50-watt mobile VHF units tuned to the same frequency as the base stations, and will thereby be able to maintain communication with the Fort St. John dispatcher at all times.

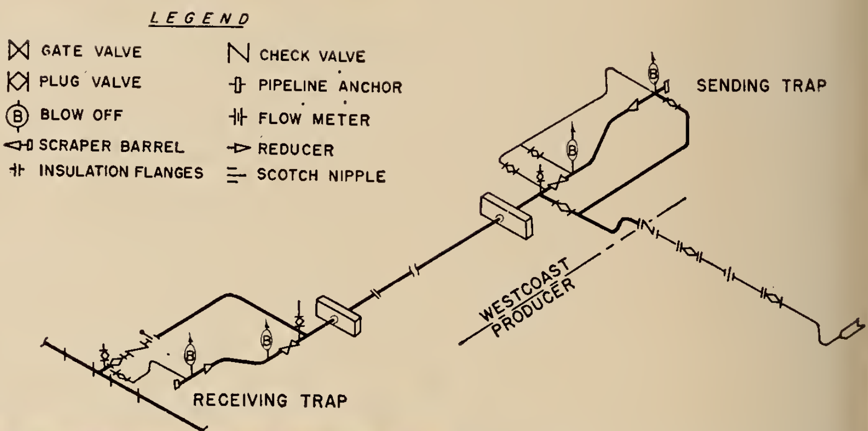


Fig. 7 (above). Typical gathering line, showing pigging facilities.

(Below). A further view of the interior of the refinery at Taylor, B.C.

The field operator has installed a VHF radio system which covers roughly the same area as the Transmission Company system. The dispatch office for the field operator will be the same building as the Transmission Company dispatch office, so that close control may be kept over the entire system.

The main remote control unit in the Fort St. John dispatch office will be equipped with a telephone interconnection so that the VHF system can be connected by private leased voice channels directly to the Vancouver dispatch office.

Operation

The system will operate at a comparatively high load factor, since the major portion of the load is at a 90 per cent load factor. The long main transmission line necessitates gathering system dispatching one to two days ahead of actual consumption. There will be in the order of one billion cubic feet of gas in line storage in the gathering and transmission system at all times.

Figure 7 illustrates the type of pigging facilities installed on all main gathering lines in Alberta and British Columbia such that on-stream pigging can be accomplished without interrupting the normal flow of gas. It is believed that periodic cleaning of the pipeline will be required to maintain pipeline design efficiency. However, in the wet gas system, routine pigging will not be relied on to materially reduce liquid hold-up in the line, thereby maintaining overall pressure drops less than those anticipated under reasonably stable flow conditions.

This rather widespread gathering system, which connects a continuously growing gas reserve to a rapidly expanding market area, requires that the design be kept flexible and capable of future expansion. The initial system is scheduled to be put into service in the fall of 1957.

Top to bottom: Boom tractors handling pipe (wrapping machinery in the background); lowering pipe into ditch dredged in Pine River, Pine Pass, B.C., Aug., 1956; view from top of Angels Peak, looking downstream (July 1956).

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A Major Power Plan for Yukon River Waters in the Canadian Northwest

J. M. Wardle, M.E.I.C.
Northwest Power Industries Limited, Ottawa, Ontario

A paper read at the 71st Annual General and Professional Meeting of the Engineering Institute of Canada, Banff, Alta., June 1957

THE YUKON RIVER with its tributaries is the geographical frame of the Yukon Territory and its watershed includes 109,500 square miles of the Territory's total area of 207,076 square miles. Because of the great transportation facility the river has provided over the years all activities in the Yukon area have been closely associated with it. In the early days it was the main agency in exploration and the development of the fur trade and, many years later, in the discovery of free gold.

Then after a long period of limited economy came the Second World War that made the Yukon territory a strategic defense area in the northwest. The resulting construction of roads, airfields, oil pipe lines, military installations, and the great Alaska highway gave the Yukon its second boom.

The moderate recession following the end of the war is now over and the increasing activity in the whole Yukon area rests on the firm foundation of its natural resources. These include gold, base metals, forest cover, and great water power potentials.

Probably no northern area had such publicity in its early days as the Yukon. Though the gold rush of 1849 in California was perhaps the greatest, and that in the Fraser River watershed in 1858-59 contributed most to future settlement of British Columbia, the great Yukon gold rush of 1897-98 had the fastest action combined with rich finds of free gold and the lure and romance of the far north. From the day in August 1897 that gold was discovered on Bonanza Creek there was a rapidly moving kaleidoscope of frantic gold-seekers, experiencing great hardships, loss of savings and sometime their lives, and for the luckier ones fortunes in gold. The years of 1897-98 saw the climax of the rush but today gold recovery is still a big industry in the Klondyke river district near Dawson City where gold dredges operate throughout each summer season. Base metal ores have been discovered and are in various stages of development, and intensive geological exploration is underway. In the pioneer days of the Yukon area the Hudson's Bay Company was to the fore and in 1842 had extended its interests to the Yukon River watershed. In May 1898 the White Pass and Yukon Route Company began the construction of its narrow gauge railway. Today, nearly 60 years later, this line still serves the Yukon area.

The name "Yukon" has long had a romantic appeal, associated as the territory has been with the spectacular gold rush of some sixty years ago. Many studies have since been made of the possibilities of developing useful power from the resources of this area. The political and physical problems involved are discussed in this paper.

It was in the same Yukon river valley that some ten years ago the possibility of "white gold" in large amounts was seriously considered. Before this the Yukon River was not considered as having large power potentials that would offer economical development; but as the need for low-cost hydro-electric power steadily increased, consideration was given to what the Yukon river watershed might have to offer. Interest in this area was heightened by the existence of several large fresh-water lakes at the headwaters of the river and which had a total surface area of over 640 square miles. The possibilities of securing the essential storage required for a northern power development were thus very great and constituted one of the great assets of the Yukon river basin. Since the Yukon river is navigable for a thousand miles, from Whitehorse northerly, one of the early problems in any power plan was the need to protect navigation facilities. River transportation in both the Yukon Territory and Alaska was carried on by shallow draught stern-wheel steamers, usually burning wood, which travelled from Whitehorse down the river to Dawson City and on through Alaska to Fort Yukon and Tanana. Fairbanks the main interior centre of Alaska, is about one hundred miles due south of Fort Yukon and for years depended on river navigation on the Yukon and Tanana rivers for transportation. However with the development of highway and rail systems in Alaska, and the increasing use of large aeroplanes for transportation of personnel and materials, the use of the river gradually declined and finally in September 1955 the last stern-wheel steamers in both the Yukon Territory and Alaska were beached, and river traffic on a commercial scale ended (for the time at least).

Since the Yukon river is navigable it was evident that there was no concentrated head available for power purposes. While several dam sites on the river existed in the Yukon Territory they would involve long high dams at considerable cost, which, coupled with ice troubles in winter, meant that power could not be produced at rates that could compete with other power potentials to the south and which were also nearer to power markets. One suggestion was to carry Yukon waters westerly through the coast range into Alaska to tide water where generating plants could be constructed in Alaskan territory with a total head available of some 2,000 feet. This plan was considered in 1946-47 by the Aluminum Company of America (Alcoa) which approached the Government of Canada for permission to make investigations. This Company undertook preliminary field work in both Canada and Alaska. In the fall of 1949 United States' Government authorities suggested to Canada that the project be an international one, following the same general plan but financed by the two countries. Though Canada would not be committed to this suggestion it was agreed that each country would make surveys of their respective power areas. These surveys, made in 1950, were limited to topographical mapping, facilities for additional stream flow measurements, soundings, and limited geological work. Each country paid for the work done in its own territory.

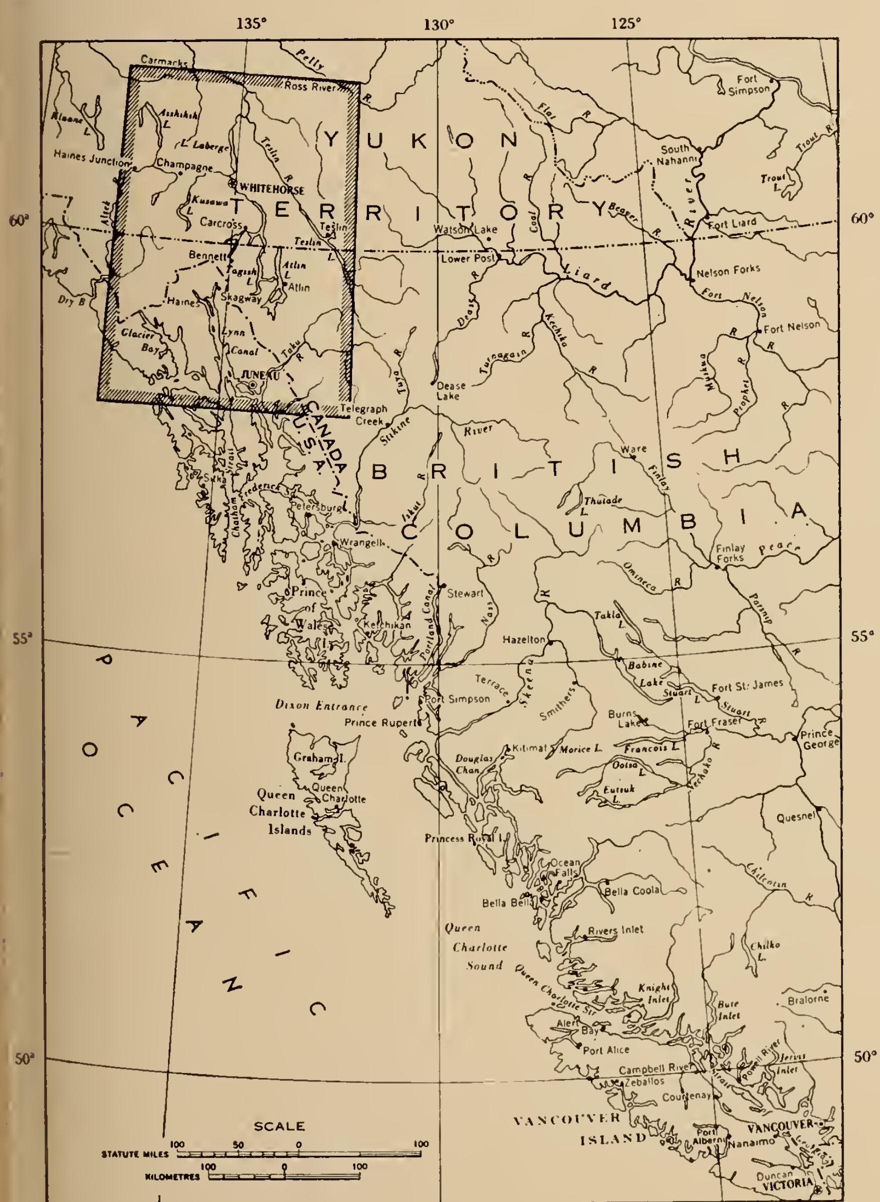
However in the fall of 1950 the Government of Canada decided that it was not in the national interest to permit the diversion of Canadian water to another country for power if it could be developed and used in Canada. No further work was done towards a joint project.

In 1952-53 the large mining organization of Ventures Limited, coupled with its subsidiaries Frobisher Limited and Quebec Metallurgical Industries Ltd., became interested in the possibilities of major power development in the northwest for metallurgical purposes, including the recovery of aluminum, copper, iron and nickel from raw ores, and decided to investigate power potentials. The author was asked in the fall of 1952 to act as consulting engineer and see if four or five million horsepower could be developed at competitive cost in the Canadian northwest, perhaps in the Yukon Territory. A condition laid down by the Government of Canada was that any such power project would have to be planned so that generating plants, and industrial plants using the power, would be in Canada.

Although it was felt that the Yukon river, with the large lakes at its source, was likely to be the answer, the decision to use Yukon power was not made without considering other possible sites in the northwest. All information available from any source was obtained on numerous watersheds, including the Alsek, Peace, Liard, Slave, Stikine, Skeena, and Nass, as well as smaller rivers on the Pacific coast. There were several streams with large power potentials, but the Ventures—Frobisher—Quebec Metallurgical group was primarily interested in power areas that could eventually provide an output of 4-million horsepower, or more. The Fraser river in British Columbia had great possibilities, but the very valuable fishing industry associated with it indicated a serious delay in reaching a satisfactory arrangement between fishery and power interests.

On the other hand the Yukon River involved few controversial factors from the Canadian standpoint and in addition it afforded the large storage areas previously mentioned. Flow records were available on the Yukon river at Whitehorse for over twenty years and the reconciliation of water levels recorded for navigation purposes with the flow records, gave flow data for a period of forty-two years. These factors resulted in the recommendation to proceed with surveys and investigations of the upper watershed of the Yukon river. This course was approved by the Ven-

Fig. 1. Key map showing the location of the Yukon River Power project in the Canadian Northwest.



tures-Frobisher-Quebec Metallurgical Industries companies in the spring of 1953. In 1954, these companies incorporated a subsidiary, Northwest Power Industries Limited, to make power investigations and plan,. construct, and operate power projects. Since that time all such activities have been under the name of this company.

At this stage two courses were open for the development of power in Canada from Yukon waters. The first of these, a series of large dams down the Yukon river, was not regarded as economically feasible. The alternative, which complied with Dominion Government policy requiring development in Canada, was to reverse the northerly flow of the upper waters and take these south through the lower end of Atlin Lake to low valleys in British Columbia where heads ranging from 500 feet to over 1,000 feet were available. This is the general plan that was adopted and for which field surveys and engineering investigations have been under way since the early summer of 1953.

Because of its latitude of from 58° 30′ to 62° N., there were special factors associated with the Yukon project and which included climate, water temperatures, earthquake hazards, fisheries, other power potentials, and the effect of glacial areas. There was also the possibility of future competition from power produced by atomic energy. These factors either affected construction costs or plant operation and maintenance.

Considerable study was given to each of these in the early stages of the investigations and before too great an expenditure was made on field work.

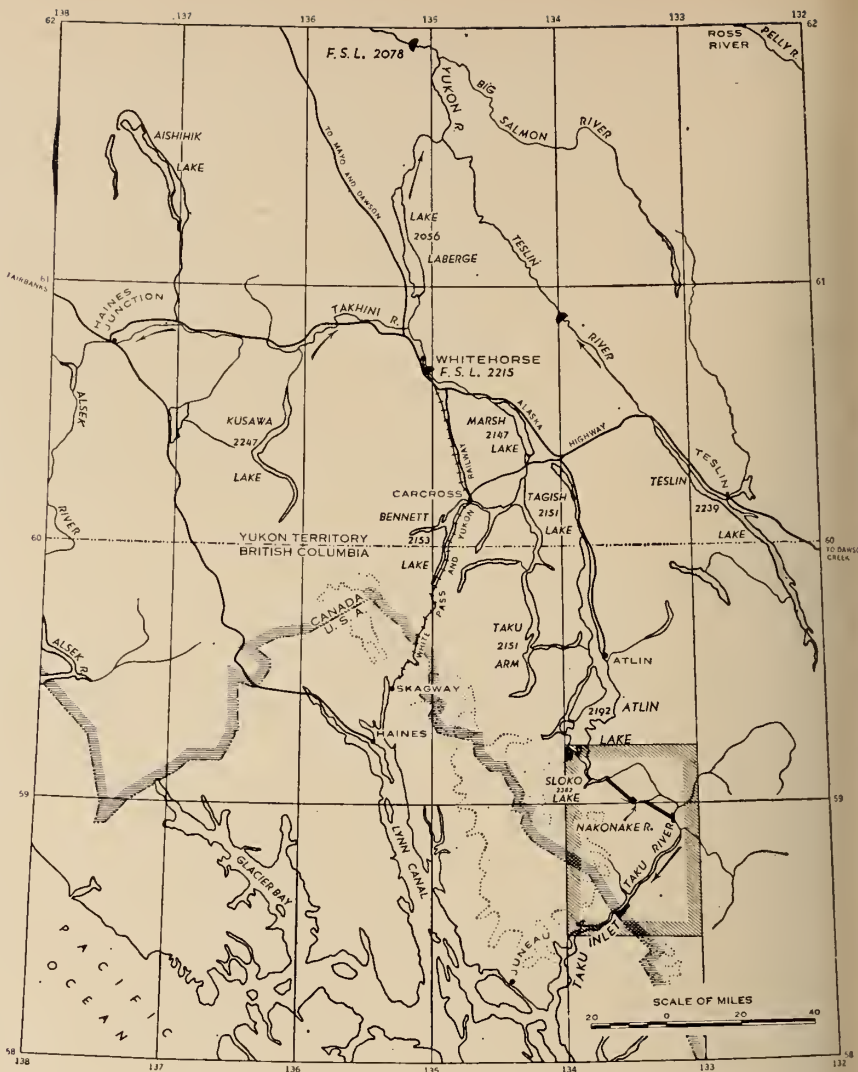


Fig. 2. General plan of the Yukon River power project.

Climate

The climatic conditions that prevail in the power area are important and worthy of record. The opinion is prevalent that in all the northerly latitudes ranging from 58° to the Arctic Circle, winters are severe with extremely low temperatures. This is not the case in the area in which the power plants, transmission lines, and industrial sites of the project will be located. This area lies roughly between altitude 58° 30′ and 59° 10′ N. Its proximity to the Pacific Coast gives it the benefit of the "Kiro Suwo" or warm Japanese current. This phenomenon, coupled with high latitude, produces cool summers and mild winters.

At Tulsequah, B.C. which is only 5 miles east of one of the proposed industrial sites, the average mean temperature in December is 21° F, January 20° F, February 16° F, July 58.8° F, September 49° F. In Montreal, Quebec, the mean temperatures for December, January, and February are 20° F, 14° F, and 15° F, respectively.

At Juneau, the capital of Alaska, 40 miles south-west of Tulsequah, B.C. the annual precipitation is 83.7 inches, while at Prince Rupert, B.C. on the sea coast, 450 miles north of Vancouver, with a population of 10,500, the precipitation is 95 inches. The annual precipitation at the proposed industrial areas near Tulsequah is estimated at 90 inches.

For eight years a hydro-electric plant has operated very successfully on the Snare River 110 miles north of Yellowknife at Latitude 63°. While temperatures as low as 62° below zero are experienced, there have been no serious ice troubles and personnel live in reasonable comfort.

No great disadvantages due to climatic conditions are thus indicated in the Yukon River power area.

Seismic Disturbances

As the Pacific coast is one of the world's major earthquake areas, and as dams and power plants would average some 150 miles from the heavy damage belt, reports were obtained on the possibility of serious earthquake hazards. Information supplied by the seismological division of the Department of Mines and Technical Surveys, Ottawa, Ontario, and from publications of the California Institute of Technology, indicates that though large earthquakes have occurred off the northern coast, none has had epicentres on the mainland nor resulted in any noticeable disturbance in the coastal mountains. For example, a severe earthquak

120 miles west of Prince Rupert, British Columbia, in 1949, caused no damage in that city.

It appears, therefore, that the Atlin-Taku area would be a reasonable risk for major power installations.

Fisheries

The effect of major power projects in the northwest on salmon reproduction is an important factor. Reports have already been obtained on the possible effect of the Yukon river power project upon salmon reproduction. Information obtained shows that this would not be a factor to interfere with an economical development. The lakes at the headwaters of the Yukon river are so far removed from the Pacific ocean that very few salmon reach them for spawning purposes. On the Taku river, which carries a large amount of silt for several months of the year, the greatly increased flow of comparatively clear water through the power tunnels may have a beneficial effect on fish reproduction. Below Whitehorse a few salmon are taken, but not for commercial purposes.

Other Power Potentials

The Yukon power project does not exhaust potential power sites in the far northwest nor does it place too much power development in the hands of a private company. A review made of potential power areas in northern British Columbia and the Yukon Territory shows that in addition to power from the major project a large amount will be available for mining and industrial development at well-distributed points. It is estimated that there will be at least 161,000 horsepower in the Yukon Territory and 463,000 horsepower in northwest British Columbia.

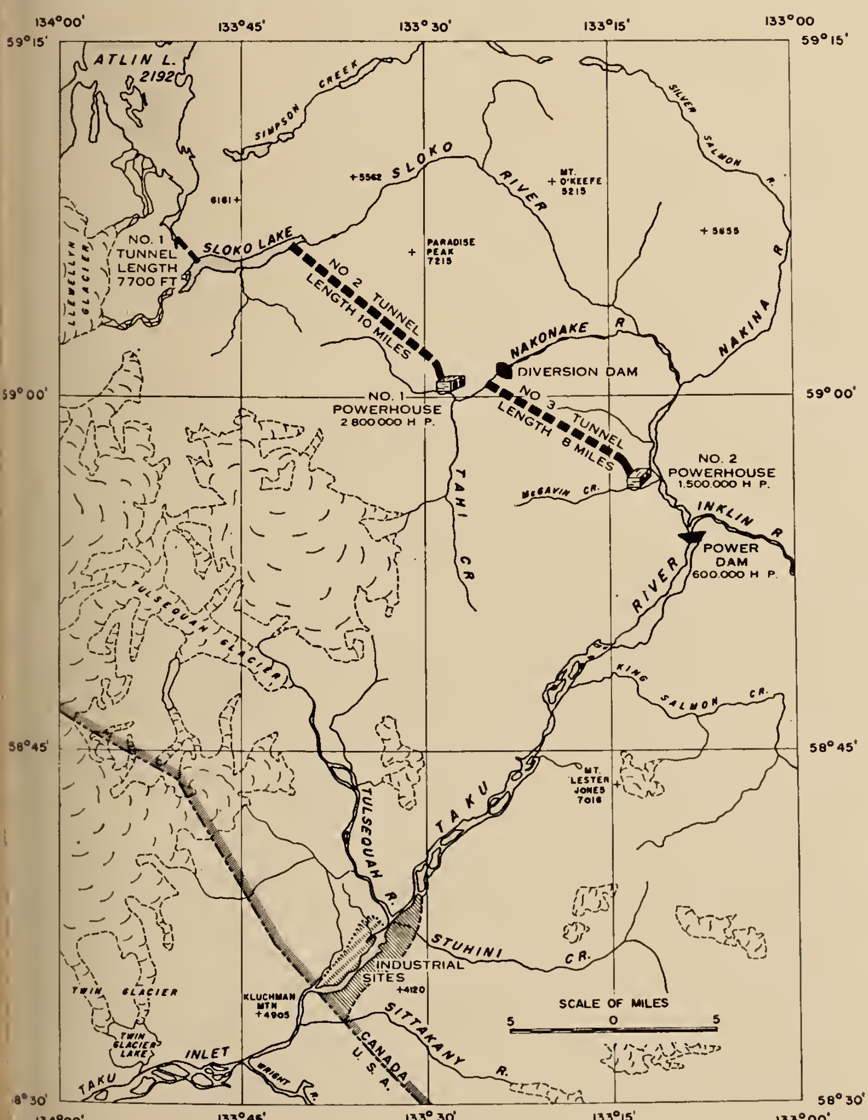


Fig. 3. Location plan of the main tunnels, powerhouses, and power dam for the Yukon River/Atlin Lake/Taku River power project.

Effect of Glacial Areas

The Juneau icefield which feeds several glaciers in the Pacific northwest near the power area has two arms that discharge into the Taku river valley from the north, about sixteen miles west of the international boundary. One of these is the well-known Taku glacier and the other is its distributary arm, called Hole-in-the-Wall glacier. Their behaviour is abnormal because, while other glaciers in the area are steadily receding, the Taku glacier has advanced some 3½ miles over the past fifty years. The Hole-in-the-Wall glacier has also been advancing during the same period. There were evidences in the Taku river valley near the international boundary that the water level had at one time been 90-feet higher than the present level and Indian legend had the story that this was caused by the Taku glacier advancing across the river valley and damming up the Taku river flow to cause a large inland lake. Investigations carried out by glacial experts in the Juneau icefield area showed that even if this had once happened there was no possibility of it occurring again under present climatic conditions. Glaciologists know that ice conditions two hundred years ago were tremendously different to what they are now. In northern British Columbia at that time glaciation was probably at an intense alpine stage and there were great accumulations of ice in all the valleys of the coast range. Since then there has been a tremendous reduction of ice accumulation coupled, except in the cases mentioned, with glacial recession. As a result there is very much less ice for the Taku glacier to draw on than there was two hundred years ago. The advance of the glacier is thus not due to increased ice accumulation but perhaps to some readjustment of the flow in the centre of the main glacial area and higher temperatures. Measurements on the Taku glacier in 1952 seem to support this theory because they showed a settlement of the ice surface, through melting, of from one to seven inches per day during July and August.

To block the Taku river and back water up to even the lower generating plant would require an advance of the Taku glacier over the 9000 ft. channel of the Taku river with an ice barrier over 290 feet high. As it happens, two years ago, further glaciological studies indicated that the high water level previously mentioned was not fresh water but sea water and that in the interim the coastal areas had been raised some 80 to 90 feet.

Power from Atomic Energy

The possibilities of competition from this thermal source have been given careful consideration, particularly in view of the progress being made in the design of nuclear power plants. The plant that opened at Calder Hall, England in October 1956, and which develops nuclear power in connection with the manufacture of plutonium, is a notable example. It appears that there is little likelihood of power from atomic energy being a serious competitor to large hydro-electric developments in the foreseeable future. In a comparatively short period of years it may compete successfully with plants using coal, oil, or natural gas for fuel, particularly in regions where transportation cost of fuel is the governing factor. It is quite possible that the high cost of hydro-electric plants in very remote or northern areas coupled with long transmission lines, will eventually make them non-competitive and thus open additional fields for power from atomic energy.

The favourable information obtained on the several factors mentioned confirmed the decision to proceed vigorously with field investigations and office studies of the proposed Yukon River project. The power plan that has been selected and for which extensive surveys have been under way for the past four years, is described hereunder.

Power Plan

This adapts itself readily to stage construction, which is one of its most important assets. Power output can be planned to keep in step with anticipated markets, and beginning with 250,000 h.p. can ultimately through four major stages, reach a maximum of 4,900,000 h.p.

Stage 1

The large upper lakes, which include Atlin, Lindeman, Bennett, Tagish, Taku Arm, and Marsh lakes have elevations ranging from 2192 feet to 2147 feet above seal level. It is proposed to raise all these lakes to a f.s.l. of 2215 feet by a dam a few miles above Whitehorse, Yukon Territory. The large reservoir so created will extend south in three great arms ranging in length from 50 to 12(miles.

The mean flow of the Yukon rive at Whitehorse over the past ten-yea period averages some 8,450 c.f.s. equivalent to 6,117,800 ac. ft. pe year. The reservoir capacity betwee a proposed l.s.l. of 2195 feet an f.s.l. of 2215 feet is estimated at 6, 814,000 ac. ft.

This water will flow through Atli lake to a tunnel which will carry i to Sloko lake. The latter will be use as a power canal to carry the wate to the portal of tunnel No. 2. Thi tunnel, which will be 10 miles lon will discharge the water into a pov erhouse on the Nakonake river und a gross head of 1090 feet. An est mated 880,000 h.p. will be deve oped here. An interesting feature the use of Sloko lake as a canal, sin its elevation is 190 feet higher th Atlin lake. Consequently unless wh lowered its carrying capacity wou be 28,000 c.f.s. or more, a review the general tunnel system would l necessary.

To obtain this essential informati a survey party in March 1954 to soundings through the ice cover. grid was established in deep sno over the entire lake and 543 soun ings were taken. These, when pl

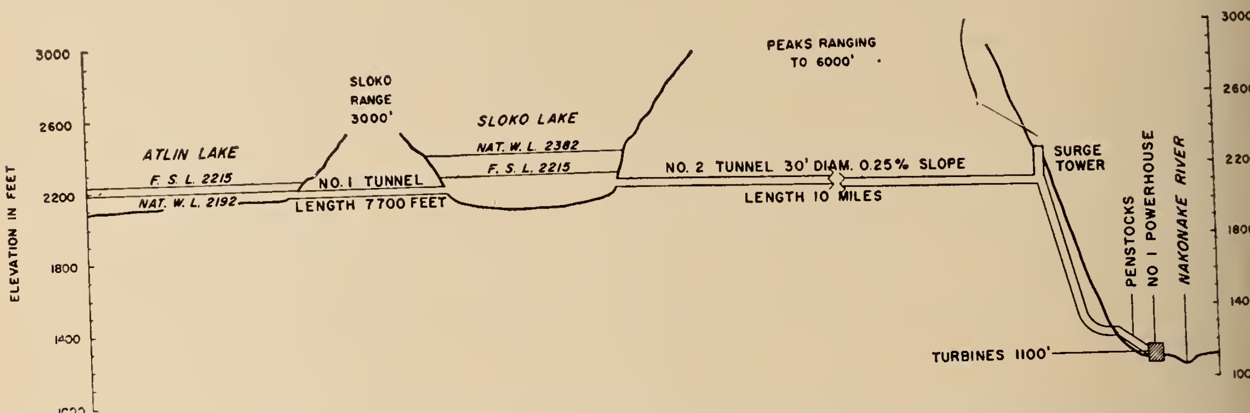


Fig. 4. Sketch profiles of tunnels 1 and 2 leading to No. 1 powerhouse on the Nakonake River.

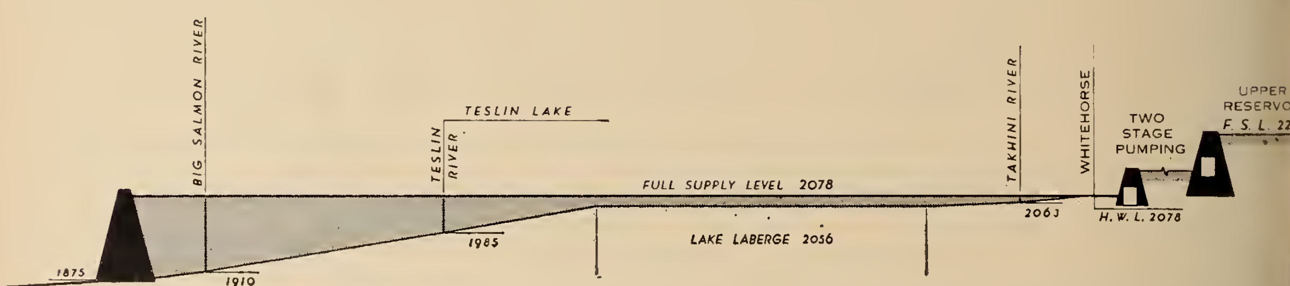


Fig. 5. Sketch profile of the lower reservoir with main storage dam for the Yukon power project.

ted, showed that the minimum cross-section of Sloko lake, when drawn down from 2382 feet to 2192 feet, could carry 28,000 c.f.s. at a velocity of one foot per second. The existence of a satisfactory ice-cover during the low temperature winter months was also assured.

Stage 2

This stage consists essentially of increasing the amount of water available in the reservoir by the addition of water from Teslin Lake and River which lie to the northeast of Atlin lake. Teslin is a very large lake, and the mean flow of the Teslin river which drains it is 11,800 c.f.s. Its flow is thus considerably larger than the flow of the Yukon river at Whitehorse. It is proposed to regulate the flow of the Teslin river by a storage dam at the mouth of the Mary river some thirty-five miles below the outlet of the lake) so that a minimum of 6,900 c.f.s. can be diverted into the upper reservoir. This diversion will involve power canals and a tunnel. In 1955 a survey of the diversion was made, but the economic study made possible by the information collected has not yet been completed. This may show that a low-lift pumping plant at the summit of the diversion may be preferable to longer canal and tunnel sections.

With a minimum of 6,000 c.f.s. diverted into the upper reservoir at Marsh lake the power output at the Nakonake river power plant will be increased to 1,540,000 horsepower.

Fig. 6. Echo-sounding raft at the damsite, Miles Canyon, Yukon River.

Stage 3

An advanced stage of development will be reached at this point, as it is proposed to impound waters below (north of) the Whitehorse dam and thus create a lower reservoir.

The lower storage dam required on the Yukon river would be built below the mouth of the Big Salmon river and would raise the level of the river channels, Lake Laberge, and smaller lakes, to an elevation of 2078 feet; which is the normal high water mark at Whitehorse. A maximum lift of approximately 140 feet would bring this water to the upper reservoir where it would be utilized under a head of 1090 feet. The lower reservoir would also impound waters from Yukon tributaries below Whitehorse, including the Teslin river waters not already diverted, and including the waters of the Takhini and Mendenhall rivers. Upper waters of the Alsek river to the west would be reversed by a dam on the Dezadeash river to flow into the Mendenhall river through a diversion surveyed in 1953. These waters, together with those of the Big Salmon, would give a total regulated flow at the south end of Atlin lake of 28,000 c.f.s. The total output at the Nakonake river power plant would, under stage 3, be increased to 2,800,000 horsepower. If necessary in the future, consideration could be given to the diversion of water from the Kluane lake watershed, some 125 miles west of Whitehorse where a minimum of 2,000 c.f.s. would be available.

Fig. 7. Sloko River Falls; Sloko Lake at upper right.

Stage 4

Under present plans the next step would be to drive the eight-mile tunnel between the Nakonake river and the Taku river, which would create a head of 550 feet. In the meantime the estimated flow of 28,000 c.f.s.

at the south end of Atlin lake, as available from stage 3, would be increased by the flow of the Sloko lake watershed and upper Nakonake river, besides one or two smaller tributary streams. An estimated 1,500,000 horsepower can thus be developed at the plant on the northwest bank of the Taku river.

During 1956 a promising dam site was located on the main stem of the Taku river itself, just below the mouth of the Inklin river, and a preliminary survey was made. Part of the natural flow of the Taku and Inklin rivers could be impounded here to give, with the northerly waters, a flow of well over 30,000 c.f.s. A power plant at the dam site would give approximately another 600,000 horsepower, or a total potential of 4,900,000 horsepower.

The latter two stages are many years in the future, and the time of their construction will depend upon the development of the tremendous power market that will be necessary. Information will be available in 1957 for the design of stage 1, and certain features of stage 2, but much definitive information is required for stages 3 and 4. As the project develops other sources of water, through diversions, may suggest themselves and there is thus the possibility of over 5-million horsepower being developed if market conditions should warrant it. The power situation in Canada from twelve to fifteen years hence will govern just how far the vast Yukon project should be carried.

Tunnels

As shown on the accompanying plan, three tunnels will be required to bring water to the generating plants, the first of these, No. 1, carrying water on an even grade from the lower end of Atlin lake, (Sloko inlet) to Sloko lake. No. 1 tunnel will be 7700 feet long; No. 2 tunnel will carry water under head from the east end of Sloko lake to the generating plant on the Nakonake river and will be from 10 to 10.2 miles long; No. 3 tunnel, which will carry water from a diversion dam below the Nakonake power plant to the proposed generating plant on the Taku river, will be approximately 8 miles long. (Fig. 3.)

Several factors will enter into tunnel planning and design.

If Yukon power were within transmitting distance of a major grid with an assured demand it would not be difficult to decide on the capacity of the initial structures. However, power loads in the area are negligible and a market must be developed, based on mining and the processing of raw materials in great quantities. To carry a flow of 28,000 c.f.s. at normal velocity would require an unlined tunnel with a diameter of some 60 feet. A lined tunnel with higher velocity would have a diameter of approximately 50 feet. The great size of the tunnels required, and their length and cost, prohibit construction to ultimate capacity in the early stages of the development. Consequently smaller tunnels will be built first, in the nature of pioneer tunnels. As the power load develops, larger tunnels will be driven parallel to the pioneer tunnels, and with the same gradients unless rock encountered by the pioneer tunnels shows the necessity of some change in alignment. The proposed diameter of the pioneer tunnels is about 30 feet, which could carry approximately 9000 c.f.s.

Considerable study has yet to be made to choose lined or unlined tunnels, where the latter are possible. From a construction standpoint alone it might be economical to drive the larger unlined tunnel section but there are other factors that may not be weighed until actual construction is under way.

In No. 1 tunnel the rock types encountered will be basalt lavas, limestone, and sandstone. When excavation is well advanced at the portals the denser undisturbed rock may stand up adequately. However, its weak features will be schistose composition and its water-soluble content. Lining will consequently be necessary through this type of rock. The other rock formations mentioned, though dense and compact, will be affected by continuous passage of water, and solution cavities are bound to form. As these could lead to rock falls and cave-ins it is expected that all of No. 1 tunnel would be lined.

In the case of No. 2 tunnel, at least two-thirds of its length from Sloko lake south will be in Cretaceous volcanic rock. The lower end in the Nakonake river valley will be in Jurassic sedimentary rock. These rocks are strong, and no tunnel lining should be required. However, it is planned to line the lower end of No. 2 tunnel to prevent erosion in the limestone beds. It is not expected that any serious flows or ground water pressures will be encountered and the centre section of the tunnel under the mountain ridge should be relatively dry.

Geological information on the No. 3 tunnel area does not show any great differences in rock structures but no drilling has yet been done. There are indications that more sedimentary rock may be encountered.

The procedure followed in the investigations of tunnel areas, dam sites

Fig. 8. Helicopter at the powerhouse site, Nakonake River.

and power plant sites may be of interest.

After the location of these future works had been tentatively determined from the engineering standpoint, geologists made a study of rock formations. Minor changes in location were then made, if advisable, particular attention being paid to the geology at tunnel portals.

Intensive geological studies were made of the proposed Yukon river dam near Whitehorse, and of the site of the No. 1 power plant on the Nakonake river, south of Sloko lake. These studies were followed in the same season by seismic surveys to determine depths of overburden. In the following year (1956) core drilling was undertaken at the various sites.

The rock structure at the proposed Whitehorse dam site consisted of basalt overlying a granodiorite base. Drill holes on the site selected revealed that unconsolidated sedimentary material existed in varying depths between the two rock formations. Consequently further drilling was undertaken a few hundred feet downstream where granodiorite was exposed and where a reasonably close contact between the basalt and granodiorite might exist. This program was not completed, and further drilling is planned for 1957.

Control of the Water

The Yukon river is an international stream, with its source in Canada and its mouth in Alaska on the Bering Sea. Its total length including the large lakes at its headwaters, is 1,700 miles, of which 570 miles are in Canada.

Though substantial areas of the large lakes are in British Columbia, the Dominion Government exercises control over the development of the Canadian section of the river because of its international character. The Alaskan section is under the jurisdiction of the United States. Canada has the right under the International Boundary Waters treaty of 1909 to divert international waters within its boundaries for beneficial use, but there is the diminishing problem of the effect on navigation when Yukon river waters are diverted to the south. Navigation on the Yukon river is protected by the Washington treaty of 1871 which states that "the navigation of the Rivers Yukon (Porcupine and Stikine), ascending and descending from, to, and into the sea, shall forever remain free and open for the purposes of commerce to the subjects of Her Britannic Majesty and to the citizens of the United States, subject to any laws and regulations of either country within its own territory, not inconsistent with such privilege of free navigation."

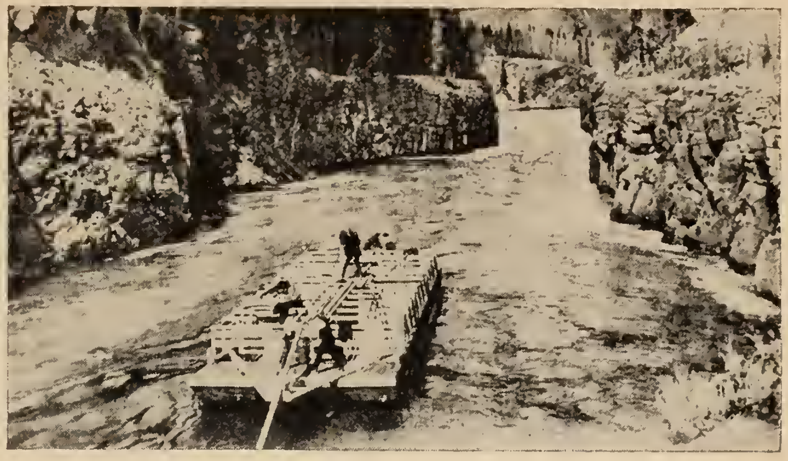


Fig. 9. Miles Canyon, on the Yukon River, in 1898.

In Canada, the Miles Canyon and Whitehorse Rapids sections are natural obstructions to navigation, and the building of a dam will not affect existing conditions except for the better. The proposed lower reservoir will benefit navigation on the stretch of river between Whitehorse and the dam near the Big Salmon river and if it is found the latter dam seriously interferes with the commercial use of the river, locks will have to be provided. There are strong indications that there will be little or no navigation on the Yukon river by the time the lower storage dam at the Big Salmon river is built.

The attitude of the United States requires careful consideration. Though the project requires no dams in Alaska, objections to the diversion of Yukon waters might be advanced because of lower water levels. Such objections, however, would be largely academic, for several reasons. Transportation on the Yukon River in Alaska on a commercial scale ended in 1955 and its revival is doubtful for the reasons previously given.

From the technical angle any ill effects of the diversion of upper Yukon River waters on navigation in Alaska can be practically nullified.

The mean flow of the Yukon River at the international boundary between Canada and Alaska is estimated at 79,000 c.f.s., and initially only 11 per cent will be diverted to the south. The maximum diversion of water originating in the Yukon territory watershed will not likely exceed 30 per cent.

For several years there will be surplus water that can be released from the storage reservoirs in Canada at the critical periods in the spring and fall to ensure conditions are at least as favourable as before the power development.

The Yukon river has also many tributaries below the northerly lower storage dam that augment its flow through the northern Yukon and Alaska, and during the summer runoff there is water to spare. Regulation of the Yukon river waters will also alleviate summer flood conditions in the lower reaches.

When full use of stored waters is required for power purposes there are at least two tributary rivers in Yukon Territory below the proposed storage reservoirs where sufficient water can be impounded for release during the short critical navigation periods in the spring and fall.

The wording of the Oregon Treaty of 1846 between Great Britain and the United States should not be overlooked when considering the navigation question. This treaty deals with the Columbia river, an international stream, and provides under Article II that the river south of the international boundary shall be free and open and that "British subjects, with their goods and produce, shall be treated on the same footing as citizens of the United States; it being, however, always understood that nothing in this Article shall be construed as preventing or intending to prevent, the Government of the United States from making any regulations respecting the navigation of the said river or rivers, not inconsistent with the present Treaty."

Since this treaty was in effect, the United States has given permission for the construction of six large dams on its section of the Columbia river. In only one case was Canada officially consulted in advance.

Under the circumstances it would seem that no serious objections can be made to the proposed diversion of Yukon river waters in Canada, particularly in view of remedial measures that can be taken in the interests of navigation.

Industrial Sites

The selection of a suitable industrial site where large plants could be established to use Yukon river power required a good deal of study. The Canada-Alaska boundary line as finally decided in 1903 deprived Canada of deep water ports on the Pacific coast from the Portland canal, latitude 55° north, to the 60th parallel. The adjudication of the boundary tribunal has definitely retarded the development of the Canadian northwest. The Alaska strip west of the boundary has also suffered from the lack of deep water ports on the Canadian coast because it is to the east in Canadian territory that the main natural resources of this northwest area are located. The story of the boundary settlements is a long one and the difficulties stemmed from the treaty of 1825 establishing a general boundary line with Russia, the United States signing a similar treaty in 1824. The treaty was written in the belief that the summit of the mountains to be taken as a boundary line were parallel to the coast whereas the mountains were jumbled and irregular and did not follow the bays and headlands. As a result the 1825 treaty really gave little guidance for the establishment of a satisfactory boundary line.

The full impact of the 1903 decision is now being experienced by both countries. In the present case it means that any Canadian industries established to use Yukon power, and meeting the requirement of the Canadian Government that generating plants and industrial plants must be in Canada, would have an overland transportation problem from the Canada-Alaska boundary to deep water in the Alaska Panhandle.

After considerable investigation a satisfactory industrial area was found on the south bank of the Taku river just east of the international boundary where some 1100 acres or more of level ground are available with reasonable development costs. On the opposite side of the river there are another 4,000 acres which could be developed later on if the cost is justified by industrial development. Detailed surveys of the site on the south side of the Taku river have been made. From the site to deep water on Taku inlet is 22 miles. Initially a road will be built over this section for construction and general development purposes, to be followed by a narrow gauge railway or a monorail installation as industrial plants develop. While the deep water wharfage is in Alaskan territory it will merely be a transfer point. Raw ores coming into the Taku river plants for processing are not dutiable and plant products will go through in bond except when consigned to United States ports where duty would be paid in any case. While this arrangement is not of course as satisfactory as a deep water port in Canada, the size of the project is such that overland transportation does not seriously prejudice it.

There is also an alternative port, which can be used as power needs grow. The all-Canadian port of Alice Arm to the south, at the eastern end of Observatory Inlet is satisfactory for navigation and climate, and there are industrial sites on tide water. This harbour, which is open to navigation throughout the year, is only 360 miles from the northern generating plants on the Nakonake and Taku rivers, which is a reasonable transmitting distance for large blocks of power. It is expected that certain industries may be established at Alice Arm if their power demands are large enough.

The Taku river sites could initially be used by metallurgical plants that may require up to a total of one million horse power. Detailed surveys of the Alice Arm area have been underway and it is expected a selection from several possible sites will be made in 1957.

Fig. 10. Freighting around Whitehorse from Miles Canyon, in 1898.

Power Demand

In planning the proposed Yukon river power project regard was given to possible markets. Increased use of hydro-electric power in the fields of mining and metallurgy, base metal production, wood products, and chemicals, was studied in an attempt to estimate the rate of increase in power demand, and the timing of construction.

The Ventures—Frobisher—Quebec Metallurgical interests, had early realized the growing need of power for the major industries and had appraised the status of large blocks of hydro-power in the Canadian northwest from twelve to fifteen years in the future.

There is a shortage of low-cost power in North America and the output of new plants is largely sold before these are completed. The trend in water-power development across

(*Continued on page* 1790)

The Role of Aerial Survey Methods in Canada's Northward Development

H. S. Scott,
*Technical Director, Hunting Technical & Exploration Services Ltd.**

CANADA IS enjoying a period of growth and prosperity unequalled in her history, spurred by an expanding development of her natural resources. Naturally, most of this development must take place beyond the present frontiers of settlement and established transportation routes —in other words, generally northward. The cost of any operation increases with distance from the facilities of civilization; consequently, in Canada, there has been considerable economic pressure for the efficient application of existing techniques, and the development of new methods better suited to our present expansion needs.

This article deals with aerial survey methods, and how they are being employed in the development of our natural resources, especially in the north. Aerial survey and northern Canada are appropriately related, for each has helped and is contributing much toward the discovery and growth of the other.

In Canada's Twentieth Century the aeroplane plays a role not unlike that of the voyageur's canoe in earlier periods of her history. The challenge of driving back the great northern wilderness, by learning its secrets and putting them to best use, once depended largely upon the canoe as a means of transportation. Soon after World War I however, the aeroplane started toward its present position as a basic tool in Canada's northern development, not only for transport, but for other uses as well. The extent of the change is indicated by the fact that, in articles such as this, the word inaccessible is now written "inaccessible".

It is important to note that both the canoe and the bush-plane rely upon water for their operation, and the extensive networks of lakes and rivers in northern Canada have been an essential factor in their successful utilization. This point stands out when comparison is made with developments in other great unsettled regions of the world, such as the desert of central and western Australia. It should remind us that northern Canada, despite an unfriendly reputation, has many compensating hospitalities.

This article constitutes a small-scale symposium on the application of aerial photography and airborne geophysical techniques to the estimation of the geography and natural resources of large territories such as the Canadian northland. Many fields of engineering are involved in the work.

The aeroplane has broken man's restrictive ties with the ground, and this new freedom is being put to good advantage. Aerial applications having the greatest influence in the development of northern Canada may be summarized as follows:

(a) *Transportation* of men, equipment, and supplies. Here we find the aircraft carrying anything from its predecessor, the canoe, to diamond drills and building materials.

(b) *visual reconnaissance* for many purposes including landing and camp sites, access routes, general topographic and terrain appreciation, forest fire - fighting strategy, and search for missing persons.

(c) *Aerial survey,* which itself covers several widely different approaches:

(i) Aerial photographic survey, and related techniques of mapping and airphoto interpretation.

(ii) Airborne geophysical survey and interpretation.

As stated previously, the last topic, aerial survey, forms the subject of this article.

AERIAL PHOTOGRAPHY

Modern aerial photography is a far cry from the hand-held oblique exposures made in the early days of flying. The present-day survey camera is a precision instrument, giving results to very fine tolerances which are actually measured and recorded for each camera. Likewise, modern aerial film must meet critical specifications. The resulting photography combines a great variety of pictorial detail with a high order of survey accuracy.

Aerial photographic coverage in Canada started shortly after World War I. Early photographs were simple obliques, but later survey was accomplished through the simultaneous use of three cameras, one being vertical and two oblique, mounted so that a trio of photographs covered an area extending from horizon to horizon across the flight path. Successive exposures overlapped about 60 per cent in the centre strip of photographs. This system provided rapid coverage of enormous areas, and it has long been the basis of planimetric mapping in the more remote parts

*A list of the contributors to this article is appended on p. 1664.

of the country. The method has severe shortcomings however, largely because good stereoscopic analysis can be carried out only with the central strip of vertical photographs.

Aerial photography in Canada is now almost entirely confined to the vertical variety. The standard size of format is 9 by 9 inches, and the typical camera lens has a focal length of only 6 inches. This photography is therefore to be considered wide-angle, for the lens accommodates an angle of 92 degrees measured across the diagonal of the format. Features lying near the edge of a photograph are obviously depicted at a rather oblique angle.

Survey photographs are usually taken along a series of parallel flight lines. Each photograph overlaps its adjacent exposures on the same line by 60 per cent; this ensures that every point on the ground is photographed from at least two positions. In addition, the coverage from adjacent flight lines is planned to overlap by some 20 per cent.

Fig. 1. A stereometric plotting machine, used for the accurate and rapid production of contoured topographic maps.

The scale of photography is a simple geometric function of format size, focal length of the lens, and flying height. Thus at 20,000 feet above the ground, for example, a 9 by 9 inch format and 6-inch lens will yield photography at scale 1/40,000. Common scales range from 1 inch per 1000 feet to 1 inch per mile.

Within the next four or five years, aerial photography will be available for all of Canada, including the northern limits of the Arctic islands, at a scale of 1 inch to 1 mile. A large proportion is already completed. Many parts of the country have been flown at various larger scales.

Photographic scale cannot be constant, either on a single photograph, or on the photography of a given area. Topographic relief, changes in flying height and camera tilt, contribute to these variations. Effects are kept to a practical minimum by flying the survey in large blocks according to their range of elevation, by the use of control points, and by the use of corrective plotting instruments during subsequent map production. Ground control points may be supplemented, or in part replaced, by navigational control such as Shoran, and by topographic profiles obtained in flight by precise radar profiling equipment.

The 60 per cent overlap employed in most aerial photography is of vital importance in the full utilization of the photographs. It permits the use of stereophonic methods, in both mapping and interpretation. The amount of overlap, combined with the wide angle of the lens, produces a striking exaggeration of the vertical dimension as seen under a stereoscope. For typical 6-inch lens photography it is of the order of 2½ to 3 times normal. This means that an actual relief model at the scale of photography, viewed from about 18 inches, would require a like vertical exaggeration to resemble the stereoscopic view of the same photography. The importance of this feature for topographic mapping is evident; for the interpretation of other information it is even greater.

Aerial photography provides data for accurate and detailed planimetric and topographic maps, their quality depending largely upon the photographic scale and the degree of control available. Using modern photogrammetric plotting equipment, topographic maps can be produced having a contour accuracy of about 1/2000th of the flying height.

Assembled as mosaics, aerial photographs constitute a continuous picture of the terrain, available by no other means. Vast areas can be studied at one time, making use of continuity and comparison to detect subtle

Fig. 2. A segment of a highway route location, plotted on a photographic mosaic. The photo-interpreted features include detailed drainage, waterlogged areas, soil types, sand, gravel, bedrock, and the route itself.

but significant changes in the terrain and its associated features. Even aerial reconnaissance, and especially observation on the ground, permit only small portions of an area to be seen and studied at one time.

PHOTOGRAPHIC INTERPRETATION AS AN AID TO RESOURCES DEVELOPMENT

Stereoscopic interpretation is a powerful aid in a number of fields related to natural resources exploration, assessment, and development. For the purpose of description, the various applications are discussed here under separate headings. In practice however, it is generally unwise to confine the interpretation to any single field; much is to be gained by having persons in several resources fields work closely together in an integrated programme.

It should be stressed that aerial photographic interpretation is rarely expected to stand alone. As with any technique, it should be employed wherever it can best serve in attaining a particular objective. In general it finds its principal role in the prefield stages of resources and engineering studies, where it leads to an appreciation of features in a broad, unique perspective. Interpretation enables further investigation to take advantage of actual conditions in a realistic manner. The interpretation of aerial photography does not replace ground surveys; rather, it increases their effectiveness and efficiency.

To realize the full value of any interpretation, its limitations must be recognized as well as its optimum potential. Interpretation is based upon factual information, be it aerial photography or geophysical measurements, but it should not itself masquerade as undisputed fact. Interpretation may vary in reliability from fact to fancy, depending upon the interpretability of the data, and the experience and competence of the interpreter. Those who perform interpretation, and those who use it, should be aware of its variable nature. If errors are discovered they should not be unexpected, and the correct version should be applied to re-assess related interpretation.

Engineering

Every advance in the development of northern Canada brings with it a host of important engineering problems. These fall into the general category of civil engineering, but they include such widely different matters as route location, sources of fill and construction materials, hydroelectric development, building and airport sites, harbour studies, and town planning. Most of these problems present unusual difficulties in the north because of the great distances involved, the remoteness, and the vigorous climate. All are well suited in their planning, preliminary study, and construction stages to properly applied aerial photographic techniques.

Fig. 3. Photographic interpretation of conditions around a proposed dam site. The large circle defines the area in which the sources of construction materials are desired. Bedrock, gravel, impermeable fill, and other materials have been indicated. The small circle and corridor are areas where overburden depths have been mapped.

Several applications are expanded here to illustrate the breadth of the interpretational approach:

Route location studies may be undertaken by airphoto interpretation for highways, railways, pipelines, power lines, communication lines, and canals. The object in each case is similar — to select the most useful and economically feasible route. This involves the careful study and weighing of a multitude of factors such as distance, geometrics, relief, cut and fill, major construction difficulties, soil and rock types, marsh, and the need for bridges and culverts. For a short route these factors can be adequately assessed on the ground. In northern developments, however, routes of some hundreds of miles are sometimes indicated. The area in which the desired route may be selected is very great in these cases, and it is clearly not feasible to carry out all the necessary studies on the ground.

The airphoto approach to route location may be considered in two stages. In the reconnaissance stage, general information on major topographic and drainage conditions is collected for the area of interest between terminal points. Any large scale difficulties in particular are noted. An approximate location is then outlined. At this stage the photography along the proposed route —which may now be obtained especially, at larger scale — is subjected to detailed interpretation. Surface drainage, high ground—water levels, impeded vertical drainage, erratic surface flow, bedrock outcrops, shallow and deep overburden, soil composition and texture, vegetative conditions, landslide tendencies, permafrost, springs, difficult crossings, landuse, and many other features can be identified accurately and compiled by aerial photographic means. The results of the interpretation are then used in planning field work for maximum effectiveness.

Materials location by photographic interpretation can distinguish sources of bedrock, talus, boulders, gravel, sand, silts, clays, and varieties of glacial till. As an indication of reliability, it may be surprising to learn that gravel and sand location by these methods is more than 90 per cent successful. The area of a deposit can be measured, and in some cases volumes can be computed, by photographic study. Access to deposits, is taken into account during the interpretation, and field testing programmes are planned in advance upon this evidence.

Hydrology and water utilization encompass many matters of vital interest to the engineer, but a comprehensive discussion is beyond the scope of this article. Airphotos offer an excellent basis for the study of drainage systems, including such influencing factors as rock and soil conditions, vegetative cover, topography, and land-use. Even conditions affecting ground-water recharge may be recognized. Representative areas are then selected for detailed field analysis.

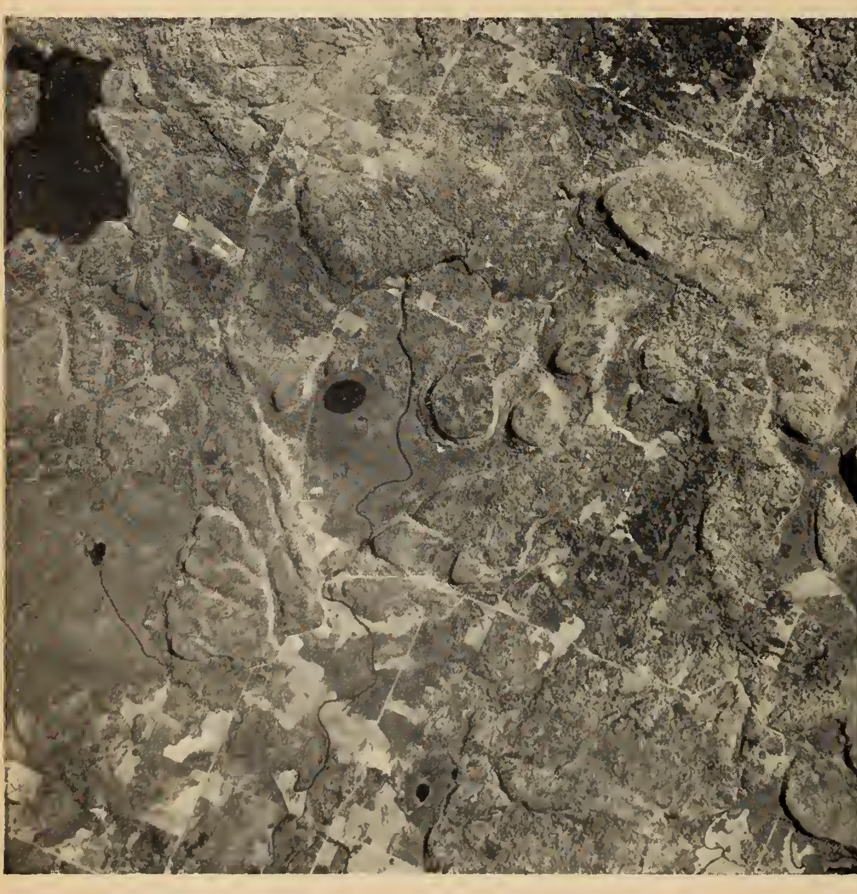
Photographic interpretation provides a wide variety of information necessary for the planning of dams and reservoirs, flood control and drainage, land reclamation, and other developments intimately related to water supply.

Sites for major construction works, such as industrial plants, dams, loading and docking facilities, airports, and towns, must be chosen only after thorough consideration of many different factors. Aerial photography provides the broad background of information necessary to undertake these tasks successfully.

Land-Use

As northern areas are opened up and developed for their pulpwood, power, and mineral resources, or for their strategic importance, there will be an increasing demand for the production of foodstuffs close at hand.

Fig. 4. Rugged outcrops, with little or no soil cover, can be seen throughout this area. Two large swamps (left and centre), each with patches of open water, are also discernible. Lower left, crops are growing on the only available flatland; here the soils are poorly drained and of poor quality. Near the top of the photograph some settlement roads have been built, but stereoscopic study shows shallow soils and rough surface unfavourable to successful farming.



The success achieved in some northern settlements proves that agriculture is justifiable under certain economic circumstances, particularly where there is a concurrence of raw materials, favourable climate and soils, power resources, markets, and adequate transport facilities.

At the present time there remains much to be learned about the potenialities of our northern lands for permanent settlement. While there are authenticated reports of excellent crops of vegetables and hay from sub-arctic communities, it is also true that agricultural settlement in these areas is of limited extent and has been only partially successful. The history of northern development provides many examples of unplanned or poorly planned settlement which has deteriorated or disappeared. Grants of free land and promotion schemes lured many settlers into areas which scientific research might have shown to be unsuitable for agriculture, or suitable only for certain types of land - use, because of poor soils, harsh climate, or some other physical or economic factor.

Comprehensive reconnaissance surveys of extensive areas of land are the only adequate means of determining where a combination of factors favourable for agriculture occurs. Such surveys should be high on the list in planning the coordinated development of Canada's northern lands. Thus agricultural surveys should accompany or closely follow forest, mineral, power, and engineering investigations, and they should include climatic and economic studies. The techniques of photographic interpretation, used in conjunction with sampling of conditions in the field, enable such studies to be carried out more rapidly than by ground survey method alone, and the results are more effective. This is particularly true in northern areas, where little land is readily accessible by road or rail.

There are four main stages in carrying out surveys required to evaluate land for agricultural use.

The first stage involves the preparation of a *soil map*. By airphoto analysis and such ground study as may be necessary to correlate airphoto patterns and ground conditions, the trained observer can identify and map land-forms, topography, surface and internal drainage, soil texture, and any other factors which may affect the quality of soil. Such a survey may profitably be undertaken concurrently with a study of soils from the engineering standpoint. At this stage, no attempt is made to evaluate the agricultural potential of the soil.

Knowledge of present land-use is essential if the best use of the land involves the preparation of a *present land-use map* by means of photographic interpretation and ground checking. The techniques of airphoto analysis have been applied to land-use mapping in many parts of the world. Categories of land - use that should be included in the classification are those which preliminary examination indicates are significant for the area under study. Forest cover is in effect a class of land-use, and therefore it should be included in a land-use map. Locations of proven mineral potential, and areas which are to be flooded, should likewise appear on the map.

The third stage involves the preparation of a *land-classification map*. This is done by classifying and rating land according to its suitability for the various uses to which it might be put. This type of classification depends primarily upon the information gathered during the soil survey. Obviously at this stage, much land can be eliminated from further consideration because such limiting factors as bedrock outcrop, shallowness of soil material, topography, and poor surface or internal drainage render it unfit for cultivation; these lands may however have some value for forestry, grazing, or other use. The better agricultural land can then be rated according to its suitability for specific land-uses, taking into account the influence of such variables as slope, erosibility, stoniness, and drainage.

The final stage is the preparation of a map showing *recommended land-use*. The findings of the land-classification survey must be correlated with those of forest, engineering, climatic, and other studies before any firm land-use recommendations are made. In assessing the agricultural potentialities of any particular undeveloped area, it is important to study the performance of agriculture in already-settled areas, which are homologous in climate, soil, and other features of environment.

The agricultural scientist assesses the foregoing results against a thorough knowledge of the climatic hazards to be expected. He must take into account the average length of the growing season and its reliability. He must know the seasonal distribution and reliability of precipitation as these factors affect cultivation. Agriculture over much of the Clay Belt in northern Ontario, for example, suffers from excessive rainfall at harvest time. Studies of the relationship between rainfall and evapo-transpiration have demonstrated that much of the Mackenzie basin is in fact a subarctic desert, a reality which must be faced when considering the potentialities of this region for agricultural development.

The agricultural scientist must also keep in mind the potentialities of an area for mining, forest, strategic, or other development, and assess the accessibility of potential agricultural lands to existing or foreseen urban localities. He must consider the possibility that two or more land-uses will compete for the same land. In many areas, for example, land which is well suited for agriculture is also capable of excellent tree growth. All these factors relative economic merits are best integrated and considered against a common base of aerial photographic interpretation.

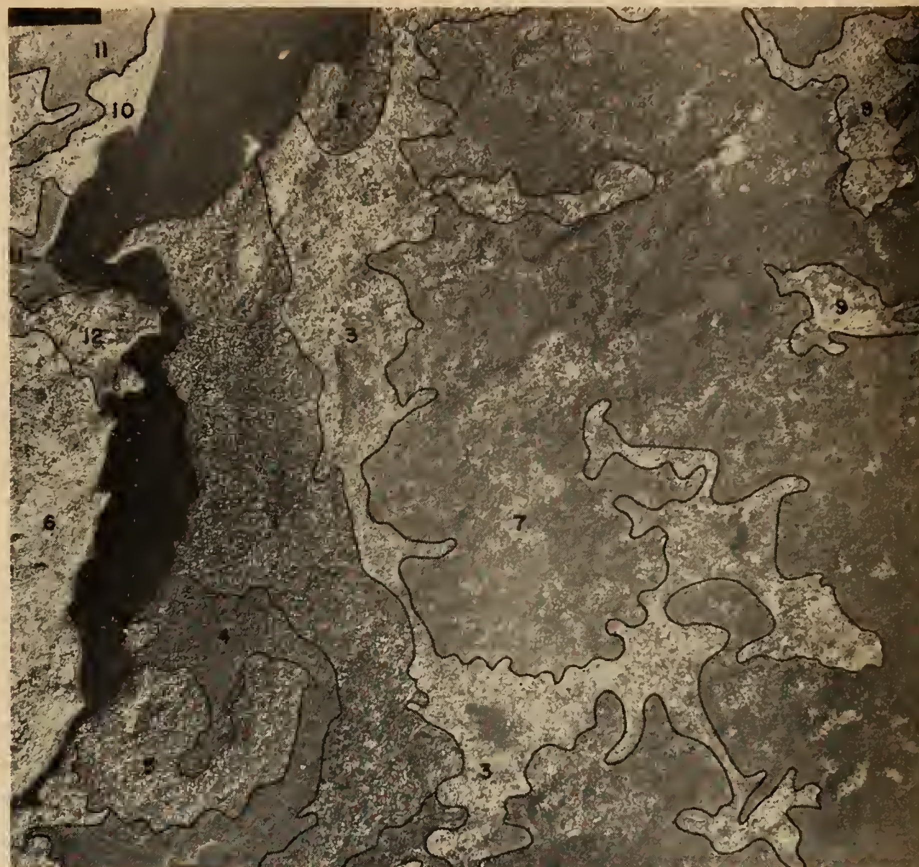


Fig. 5. Forest cover type interpretation by photo-analysis. Conspicuous variations in tone are related to the type and density of tree crowns. The numbered areas include: poplar/birch (6); black spruce (4); jack pine (7); and poplar/birch/-jack pine (3).

Forestry

The demand for Canadian forest products has increased very greatly since World War II. As a result, the forest land which is considered to be economically exploitable has been enlarged, especially in the western provinces and the Northwest Territories. Occupied forest land in Canada has increased 22 per cent since 1951.

As the demand increases, the limits of accessible productive forest land move north, into some 197,000 square miles now classed as potentially accessible. The factors of availability, transportation, and markets will, of course, govern the economic feasibility of actual forest operation in this vast area.

The northward expansion of our forest industry must be guided by knowledge of the forest resources themselves, and of the many factors that influence their efficient utilization. Aerial photographic interpretation has proven its value in areas of present forest operations, and provides the key for future expansion. The selection of areas will be influenced to some extent by the devel-

Fig. 6. With a little experience, the rock seen in this photograph can be identified as anorthosite. The network of fractures is characteristic.

opment of other natural resources, inasmuch as that will help to provide access and a ready market.

Airphoto studies for forest development are carried out in two stages:

The *reconnaissance* of vast areas to select those exhibiting the highest forest potential may be undertaken rapidly and effectively by foresters skilled in the techniques of airphoto analysis. This initial phase may be carried out using small scale aerial photography in the order of 1 inch to 1 mile. The basic interpretation carried out at this scale serves to classify the area under consideration into productive forest land, and unproductive forest land (water, muskeg, rock outcrop, non-reproducing old burns, etc.). The productive forest land is then subdivided on the basis of cover type (softwood, mixed wood, hardwood) and merchantability (merchantable and otherwise). The lower limit of merchantability is normally set at approximately four to ten cords per acre, depending largely upon the economics of transporting the cut to the mill. The preliminary airphoto reconnaissance then serves as the basis for selecting priority areas which justify further and more detailed consideration.

Inventory survey is the second stage in the programme of orderly forest industry development. It involves a detailed analysis of the growing stock on the areas selected, to determine the development potential. Aerial photography again plays an important part in carrying out this task rapidly and economically.

The reduced area is now covered with new photography at a recommended scale of 4 inches to 1 mile, using panchromatic film and a minus blue filter in mid-summer to achieve maximum distinction of the various tree species. Foresters then study each stereoscopic pair of photographs, classifying the forest cover in categories under species composition, stand height class, stand density class, and age class. The resulting forest types are compiled upon base maps of the same scale as the photography, using a Sketchmaster or similar camera lucida device for transfer. This results in the forest cover type map.

Field cruising is next required to sample timber volumes. It can be appreciated readily that this operation is reduced to a minimum through the application of airphoto techniques, in that each combination of the interpreted stand components is field sampled to a density necessary to reduce its standard error to plus or minus 1 per cent of the mean. The regular strip cruising methods formerly carried out before the general acceptance of modern photographic techniques required a great deal more ground sampling.

Fig. 7. Diabase dikes filling fractures in sheared volcanic rocks.

The stand volume table computed from the field cruise are then compiled. These results are then applied to the various forest type acreages (measured by planimeter), to produce a statement of timber volumes by species for the area under study.

The inventory is basic to all future forest development, for from these data the management plan is prepared.

Recent developments in the aerial photographic interpretation of land types and forest site types, when combined with a knowledge of silviculture and ecology, make possible the delineation of areas according to their growth potential. This interpretation when studied in conjunction with the forest cover type map is invaluable in all phases of forest management, especially those involving silivicultural treatment in order to obtain the regeneration of preferred species on cut-over lands. Land-classification maps serve effectively in the location of main haulage roads, construction materials location, townsite and camp location, particularly as forest operations push northward.

Apart from the forest industries, the applications of forest airphoto interpretation are many and varied. Sources of mine timbers and lumber close to construction sites are required as developments extend further from established supply bases. Or again, airphoto techniques may be applied to the design of seismic "shot-line" grids for petroleum exploration surveys, in order to minimize the volume of valuable timber which must be cleared and upon which crown stumpage dues must be paid, as well as to avoid difficult terrain for supply vehicles. Accurate pre-engineering estimates may be made in connection with railway, highway, pipeline, and power line construction, where timber clearing and salvage constitute a substantial portion of the total cost.

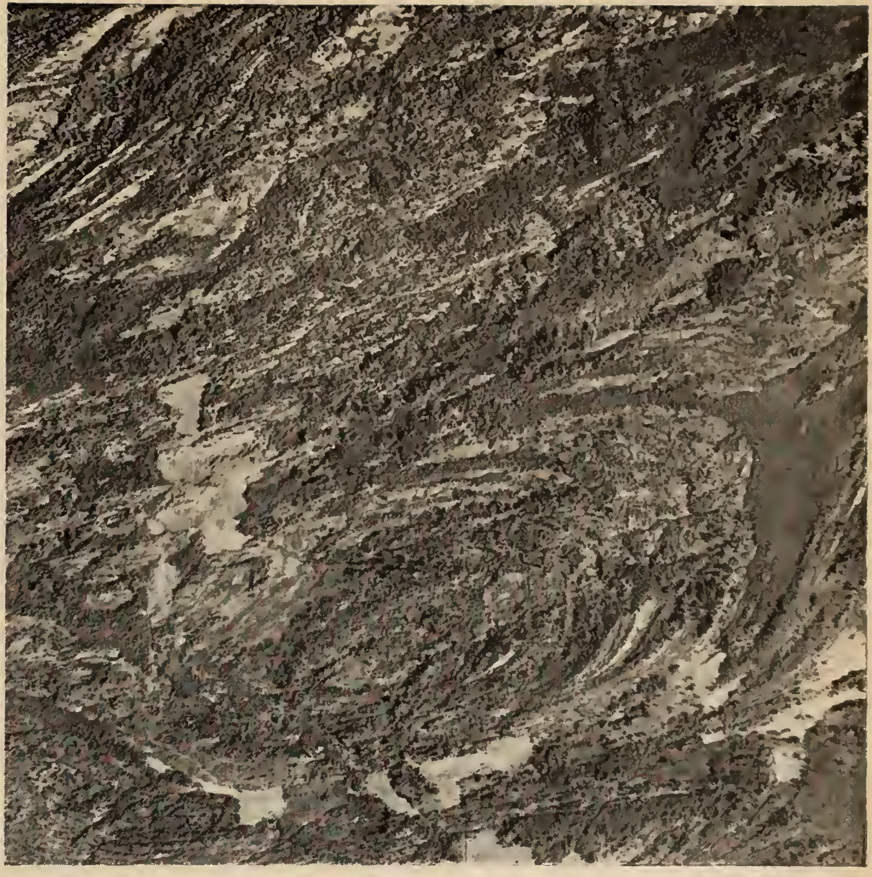


Fig. 8. Folding in a series of gneisses. For an example of a fault, see the left side of Fig. 4.

Geology

The search for economic mineral deposits in Canada's relatively little-explored northland offers a combined challenge and inducement to the mineral industry. Exploration costs are high, and they must be offset by the reasonable hope of discovery of relatively high grade mineral. On the other hand, the favourable areas for search are immense, and competition is limited.

The challenge is being met by replacing small-scale, inefficient prospecting procedures with well planned exploration campaigns. These have no place for casual prospecting without definite objectives. High costs and the short field season emphasize the need to evaluate quickly, if not exhaustively, large blocks of ground, and to concentrate additional, more detailed investigation in the more promising localities.

Aerial methods supply a good part of the answer to this challenge. Geologists are among the foremost proponents of "bush-flying", aerial reconnaissance, and airborne geophysics. Many are enthusiastic users of aerial photographic interpretation, but there is still a tendency among others to regard photo-interpretation as a lazy man's poor substitute for boots, fly dope, and sweat.

Geological airphoto interpretation is not a substitute for field work. In its broad aspects it is a source of information on a scale seldom attempted in the field. With greater attention to detail, it is an ideal complement before and during field work, increasing the effectiveness and efficiency of the latter many times.

Geological reconnaissance based upon airphoto interpretation is an excellent means of scanning a large region for areas of greatest mineral potential. The treatment can be applied to a large area surrounding a zone of interest, thereby helping to outline the most favourable locality for later field study, and providing a general geological setting for the greater understanding of later detailed observations.

An overall mosaic is made from the photography, and all available geological data are compiled upon it. Airborne geophysical results are often included at this stage. Then a general airphoto interpretation is made, partly from the mosaic, and partly from stereoscopic study of pairs of prints. The known information is expanded through the interpretation, taking care to distinguish the origin of the compiled results. The mosaic is the base upon which the geological picture develops, and any significant surface expression of the underlying geology is not apt to go unnoticed.

Interpretation on a reconnaissance scale may point to features which would otherwise require the compilation of years of detailed mapping — after the mapping became available. Thus a major linear feature, or an abrupt change in the details of topography across an invisible line, must have some explanation, and the search for that explanation may reveal an important fault, or a compositional change in a series of gneisses. Whether or not the fault can be described petrographically is of little importance at this stage. The significant point is that major elements of the geology have been recognized early in the study of an area, and subsequent work can be aimed to take fullest advantage of the interpretation.

Geological features that may be interpreted from the photography for reconnaissance purposes include the following: a general division of rock formations (which may or may not be identified in broad terms) if overburden is not excessive, faults, folds, stratification (strike and dip), dikes, and contacts. Areas of terrain regarded as unfavourable host-rock, such as large granitic bodies, may be eliminated at this stage.

An important and interesting feature of any photographic interpretation is that even where no rock exposures occur, some evidence of the underlying geology is almost certain to be found in the photography. There are several possible reasons for this useful relationship. For example, a strong shear zone in the bedrock is apt to be the site of a sharp valley where it meets the bedrock surface, buried under overburden or not. Ground - water collecting in this valley will influence the growth of vegetation even tens of feet above it. Again, the nature of the bedrock relief detail may vary from one formation to another. The lower layers of the continental ice sheet were influenced in certain ways by these differences, with resulting variations in the glacial deposition as now seen. Airphotos show these features over very large areas, so that even very subtle variations which one could not expect to notice on the ground, may fall into a significant pattern when studied on mosaics.

Detailed geological interpretation is similar to the foregoing, but the work is carried out with greater attention to detail, in smaller areas selected at least partly as a result of the reconnaissance studies. A larger scale of photography is desirable, and new coverage at say 4 inches to 1 mile may be justified. If in forested country, the survey must be done during a period when the deciduous trees are bare, and of course when the ground is free of snow. Close study of the photography, and detailed correlation with other data, will produce considerable new and valuable information upon which later field work can be based. Areas of rock outcrop can be recognized, and unless they are very general throughout the region, should be outlined to save time in field examination. Many details of rock type and structure can be interpreted and recorded if overburden is not too widespread. Dips can be measured with fair accuracy by simple photogrammetric devices where there is sufficient surface relief.

Additional information that will help in planning field work includes the tentative selection of camp sites near water suitable for use by aircraft, the amount of rock outcrop available for study, and general terrain conditions. If little or no rock can be seen, the geologist's time can be regulated accordingly and, perhaps, geophysical work planned in its place. In the latter case, use will be made of such information about regional strike and other geological factors as may be interpreted from the photography.

Geological field work itself derives much benefit from the free use of aerial photography. Aerial photographs and mosaics provide the ideal base for the recording of field observations, either on the photographs or upon a transluscent overlay. Outcrops, previously outlined by photo-interpretation, may be visited directly, thus avoiding the time wasted by routine traversing along set lines. Each plotted observation is seen immediately in relationship to other field observations, to the photo-interpretation, and to the details of the landscape. Thus it is commonly possible to project a contact after relatively few ground observations; or with a few well placed traverses, identify a formation the extent of which has already been determined from the photography. On more than one occasion, the location of an important outcrop, described in an old narrative, has been identified by study of the photography, so that the geologist can go without hestitation to that same place.

Modern prospecting sooner or later turns to geophysics for assistance. Airborne varieties of this branch of exploration are described elsewhere in this article. Geophysical survey on the ground is aided considerably by the use of aerial photography in both the planning and execution stages. The results must be interpreted in conjunction with all available geological information, including aerial photographic interpretation, to reduce the number of variables inherent in geophysical interpretation. With airborne geophysical results it is even more important that full use of photographic interpretation be made, because of their broad coverage.

As areas of potential economic interest are investigated and found to be worthy of further examination, the diamond drill is of critical importance. Diamond drill holes are located, where possible, close to a supply of water, and in such a location that the depth of overburden will be the least possible.

In later stages of development work, aerial photography provides

Fig. 9. A Canso amphibian provides the platform for three simultaneous geophysical methods: total field magnetic, dual-frequency electromagnetic, and radioactivity. In addition, a 35-mm. positioning camera and a radar-operated height-measuring device are in operation. All results are recorded continuously and automatically.

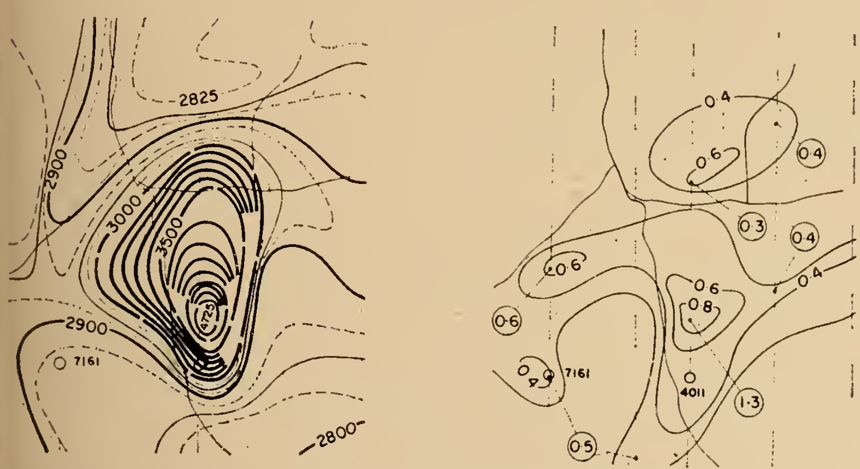


Fig. 10. The "thumbprints" or an orebody recently discovered by aerial survey near Mattagami Lake, in northwestern Quebec. At left is the magnetic anomaly caused by magnetite associated with the ore. At right is the corresponding EM anomaly, related to electrically conductive sulphide ore.

the information required to lay out access roads, whether they be rough trails for winter tractor trains or gravelled highways for cars and heavy trucks. In many instances, an airstrip will be required in the vicinity of the mineral development; its location and materials for its construction can be selected by photo-interpretation. Suitable sites will be needed for mine and mill buildings, and eventually for a townsite. A reliable base map must be made for all these aspects of development. It can be produced with or without topographic contours from aerial photography, using a minimum of ground control.

AIRBORNE GEOPHYSICAL SURVEYS

Geophysics is a relatively young science. It deals with the application of the methods of physics, to the investigation of geological conditions. In its broadest form it seeks to describe the physical constitution of the earth by the measurement and analysis of seismic, gravity, magnetic, thermal, radioactive, and other fundamental properties.

For many years it was realized by some workers that geophysical methods should be useful in the search for various kinds of mineral deposits, and during the first 30 years of the present century the new field of applied or exploration geophysics came into its own.

Until the end of World War II, all geophysical exploration was carried out on the ground, or in drill holes and mine workings. The successful wartime development of the airborne magnetometer seems to have sparked efforts toward the development of other airborne geophysical methods, and in the decade that followed, radioactivity and electromagnetic equipment has been produced and operated with marked success. Recently an airborne gravity device has been put into use.

Airborne geophysical methods tend to be regarded with awe by the layman, but it should be realized that they introduce no new principles, and that most of the techniques have fairly long histories in modified form on the ground. The biggest changes wrought by taking to the air are in the size of areas now surveyed, the ease of access to otherwise remote and difficult localities, the speed and continuity with which they are surveyed, and the relatively low cost per mile of line. In these respects airborne geophysics and geological airphoto interpretation are ideally complementary.

Airborne geophysics is carrying mineral exploration further and further north in Canada. Since only the largest deposits are economical in remote areas, and sinee airborne survey methods give a broader view than do equivalent ground methods, they are being used with a high degree of success. They are spearheading the search for petroleum in the Northwest Territories by covering tens of thousands of square miles by aeromagnetic survey. The mining industry, originally skeptical of the usefulness of geophysics and therefore slow to adopt the new approach, is now sponsoring airborne surveys with increasing enthusiasm. Mining companies report that approximately a third of their exploration budgets is now being spent on airborne geophysical survey and followup investigations on the ground.

The *airborne magnetometer* was applied to mineral search in 1946, and it has been in constant employment since. There are now about 12 aircraft performing these surveys in Canada alone. The instrument measures and records variations in the earth's total magnetic field, along parallel flight lines, and at elevations usually from 500 to 1000 feet above the ground. The aeromagnetic results are generally reduced from profile to contour form for convenient study.

Results are related to the magnetic properties of rocks in the crust, and the distances beween these rocks and magnetometer. Since magnetic properties (mainly a function of magnetite content) are fairly characteristic for most rocks in a region, the method is an excellent aid in regional geological mapping. It provides a record of fundamental data whose areal continuity is rarely equalled by any other type of information. Areas of different formations may be outlined and to some extent identified, and major structures may be deduced. The principal use of aeromagnetic survey is therefore to help delineate general geology, leading to the selection of smaller targets where detailed geological and geophysical investigation is warranted. In addition however, it responds directly to magnetite ore, and to other ores occurring with magnetite or the magnetic sulphide pyrrhotite.

The distance to a magnetic source can be calculated with reasonable reliability, and this fact is used in petroleum exploration. Most sedimentary strata are relatively "non - magnetic", whereas they lie upon a basement—usually the Precambrian complex—which has inherent strong magnetic variations. Depth determinations at suitable points therefore give some idea of sedimentary thickness, and variations in thickness may be interpreted broadly in terms of structure.

Radioactivity detection from the air was attempted shortly after the war, using banks of geiger tubes in low-flying aircraft. These have been replaced in present - day equipment by the scintillation counter, which like the geiger counter responds to gamma radiation from surface and near - surface sources. The equipment is used to prospect directly for uranium and thorium minerals, and in combination with other methods, to aid in mapping general geology.

Electromagnetic survey became airborne in 1949, and at least 15 aircraft are now engaged in this type of work in several parts of the world. Various techniques are employed, pioneered in Canada and the Scandinavian countries. All use variations of the same principle, in which an alternating electromagnetic field is generated at the aircraft, and an electrical conductor at or near the surface will set up a secondary electromagnetic field. This latter field is detected by a pickup coil, usually towed behind the aircraft, and is analyzed and recorded by electronic equipment in the aircraft. The method is a means of direct prospecting, rather than a geological mapping tool.

Concentrations of economic minerals, such as the sulphides of copper, lead, and nickel, can be discovered by electromagnetic survey. In addition, the association of pyrite and pyrrhotite with these and many other minerals broadens the range of applications. Uneconomic deposits of graphite are also detected, and must be distinguished by other means.

In Canada, EM surveys (as they are termed) cover some 50,000 square miles each year. The method has already been responsible for the discovery of at least seven Canadian base metal deposits of major importance.

The *gravity method* is the latest branch of airborne geophysics. It overcomes the vertical accelerations of flight by measuring variations in the gradient of the gravity field, rather than of the field itself. It is being used to prospect for various types of ore, and to outline geological structure. Clarification of the instrument's potential and its degree of success, must await further results. The new method demonstrates the ingenuity with which airborne exploration methods are being pioneered.

Helicopter-borne versions of airborne geophysical equipment offer a compromise between the economy and coverage of fixed-wing operation, and the greater definition and detail that result from being closer to the ground.

No airborne geophysical technique could succeed without aerial photography. The proposed flight lines are normally drawn upon a photographic mosaic, and this is used by the navigator during flight. The actual flight paths are recorded by the continuous operation of a small, vertical camera, the photographic and geophysical records being correlated by a system of numbered fiducials. The geophysical results are positioned finally on the map by referring the survey film to the photographic mosaic.

Exploration geophysics is only as helpful as its geological interpretation, so that careful interpretation is of prime importance. This requires a theoretical appreciation of the measurements (sometimes aided by model experiments), experience with the method, and sound geological judgement. The results of interpretation can rarely be unique, and there are usually two or more explanations that will satisfy a particular geophysical condition. To narrow down these variables, a combination of methods (such as magnetic and electromagnetic) is of great assistance. Here again photographic interpretation may supply the clue needed to arrive at the correct geological explanation. As an example, it may be supposed that a fault has been interpreted from aeromagnetic data, but that its position on the ground can be indicated only approximately from those data. However, a linear feature in the photography occurs in about the same position. In this case not only has the position been established, but the interpretation has been strengthened. In the opposite sense, a geological feature interpreted from the photography may direct attention and provide an important clue to a geophysical interpretation.

Radioactivity results must be studied in conjunction with the photography, not only for geological guidance but to show where overburden may mask otherwise positive results. Electromagnetic data also are improved by such comparison, for lakes may produce anomalies, and deep overburden may lay greater stress on an otherwise small EM response.

Ground follow-up is necessary to prove the importance of airborne geophysical indications, despite the most thorough interpretation procedures. A combined geological and geophysical team on the ground can investigate points of interest rapidly, and direct such additional work as diamond drilling to the best locations. Dozens of ground teams are now investigating airborne results in many parts of the Canadian north. Aerial photography contributes greatly to the efficient operation of these crews, in ways already stated under the section on "Geology".

Concluding Comments

(1.) The outstanding fact common to any type of *aerial* survey is that it is truly *areal;* very small surveys are rarely economical by aerial methods. Thus an air survey produces results of two densities:

(a) the direct, detailed findings of the survey, and (b) general information of a broad, less detailed nature whereby the former data can be studied in their regional perspective. The broad perspective adds new significance to many types of local observation.

(2.) Aerial photography is the logical base for the derivation, compilation, and comparison of many types of information. This fosters close co-operation and understanding among resources workers, and sound development of the resources themselves. There have been many examples, in government and elsewhere, whereby aerial photography has brought formerly independent departments into fuller awareness of the problems and usefulness of each other's fields.

(3.) Aerial photography relates man-made developments to various aspects of nature. Settlements, agriculture, mining and forest operations, power developments, transportation routes — all can be seen in relation to the important natural features discussed in this paper. Thus established activities can be expanded sensibly, and new developments can benefit from broader, more realistic planning from the outset.

(4.) Aerial survey methods should not overlap or compete with corresponding ground methods in any but the smallest way. Each group has its own sphere of usefulness, and supplements the other. Moreover, one often stimulates the other; for example, the results of an airborne geophysical survey often do more to promote useful ground exploration activity than any other immediate factor.

(5.) Aerial survey is rapid and relatively inexpensive. In particular, with its ready availability and its first costs already underwritten by government, it is folly to ignore the benefits to be had from the full application of photography and aeromagnetic

(*Continued on page* 1664)

View of Steep Rock Lake (Falls Bay area) before lowering of lake by Steep Rock.

The Caland Project at Steep Rock Lake

Philip D. Pearson,

Manager, Caland Ore Company Limited, Atikokan, Ontario

A paper read at the 71st Annual General and Professional Meeting of the Engineering Institute of Canada, Banff, Alta., June, 1957.

AS EARLY AS 1897 geologists have been aware of iron ore deposits in the Steep Rock Lake region. Eventually the inevitable occurred when a small group of men with a great deal of foresight followed through with this knowledge, and in February, 1938 formed Steep Rock Iron Mines Limited to continue exploring and developing the rich Steep Rock iron range.

The three main parts of the Caland program are water control, dredging, and mining. The water control projects, which entail the construction of twenty dams and associated controls, are nearly complete. By April 1st, 1957, the two large dredges have moved over 60 million cubic yards of lake bottom material from Falls Bay, or approximately 33% of the required total of 182 million cubic yards. The first underground shaft, designed for a capacity of 1½ million tons of iron ore per year, is being sunk, and plans for open pit mining are progressing. The program is well on schedule, with expectations to start production of Caland iron ore in 1960.

Inland Steel Company, the seventh largest steel company in the United States, looked to Steep Rock in 1949 when an ever increasing demand for high grade ore spurred the company on to increase its long term reserves of iron ore. There were at this same time many large developments being contemplated by Inland for large productions of iron ore in the U.S., Canada, and other countries — Inland chose Steep Rock. On January 1st, 1953, a lease was signed with Steep Rock Iron Mines Limited, and Caland Ore Company Limited was formed; the name Caland derived from the two words "CAnada" and "InLAND".

The lease from Steep Rock covers an area of 1,249 acres in the Falls Bay portion of Steep Rock Lake. This area is within the townships of Freeborn and Schwenger in the District of Rainy River, Ont., and approximately seven miles north of the residential area of the township of Atikokan. This

Falls Bay of Steep Rock Lake at start of Caland project, June, 1954.

general area is about 80 miles east of the Canadian border city of Fort Frances, and 130 miles west of the Lakehead cities of Fort William and Port Arthur; the distance between the project and Inland's steel plant at Indiana Harbor, Indiana, is 691 miles by water from the Lakehead.

Before actual mining of the iron ore below Steep Rock Lake can begin, it is necessary to construct water controls to divert away from Falls Bay the waters which normally flow towards Falls Bay. Also, before mining can begin, the layer of lake bottom material lying over the orebody, as well as the lake itself, must be removed. Consequently, the first steps necessary to start the project are to build control works and to initiate and carry out the dredging program. As the elevation of the top of the orebody at ledge varies approximately 300 feet, it will be possible to start mining the higher elevation portions of the orebody before the dredging program is completed. Caland's target is to produce 750,000 tons of ore in 1960, and to develop mines to bring the total production to 3,000,000 tons by 1969.

My address covers the three main phases of the development program, and I shall endeavour to convey to you a complete picture of the project itself, as well as our overall objective. The information is under three main headings — *Water Control, Dredging,* and *Mining.*

Water Control

Before the dredging program could be initiated, it was necessary to construct three dams and a spillway at the north end of Marmion Lake, to form a closed stilling basin 25 square miles in area, in order to prevent the discoloured water from entering the Seine River. These dams were designed by our consultants H. G. Acres & Co. Ltd. of Niagara Falls, Ont., and Dr. R. M. Hardy, Dean of the Faculty of Engineering, University of Alberta, Edmonton.

One dam, the West Marmion, is rock-filled with a 200 ft. wide area constructed with a log crib; on top, 5-ft. high flashboards were installed to allow the passage of log booms from Marmion Lake to the Seine River. The flashboards were added as a special feature to facilitate the Ontario & Minnesota Pulp Co. Ltd. spring logging operations in this area.

The other two dams are earth-

Schematic plan of the Caland project.

filled, and are known as the Middle Marmion and East Marmion dams. These three dams were completed in the spring of 1955 in time for the dredging program, and to control the water at the north end of Marmion Lake.

At the south end of Marmion Lake, the Twin Lakes recharge water control was constructed. This control is made up of two 6-ft. diameter pipes and two control gates, and permits water to flow from Marmion into North Twin Lake. The water then passes into South Twin Lake, then into Falls Bay, to complete the circuit.

For the south-east arm of Steep Rock Lake, a dam was designed to prevent surface runoff water from flowing into Falls Bay, and to support the railroad crossing of this gully. This structure, named the Fairweather Dam after Mr. S. W. Fairweather, vice-president of the Canadian National Railways, was designed by Dean Robert M. Hardy in collaboration with Dr. Arthur Casagrande of Harvard University. The dam was designed for construction in three lifts, the first of which was built in 1955, the second in 1956, and the third phase of construction was to follow the spring runoff in 1957. When the dam is completed, a pumping installation will be constructed to pump the water impounded behind the dam, into Marmion Lake, and the railroad from the Steep Rock spur to the Caland plant site will be constructed on top of the dam.

The Hardy Dam, also an earth dam, is located at the south end of the southeast arm of Steep Rock Lake and, with two rock tunnels and Margaret Lake, diverts the water runoff from an approximately 11 square miles drainage area, away from Falls Bay into the Atikokan River. This dam was named in honour of Dean Robert M. Hardy who is Caland's consultant on soil mechanics.

Before the dam was constructed, 600 acres of land were cleared of merchantable timber, and all remaining brush was cut and burned so that the lake which will form behind the Hardy Dam will be free of timber, undergrowth, and debris.

As the water is impounded behind the Hardy Dam, it will pass through the Margaret Lake east tunnel into Margaret Lake, then through Margaret Lake and out the Margaret Lake west tunnel. In the west tunnel there has been constructed a control

Construction of cribwork at one of the North Marmion Dams.

Twin Lakes recharge control.

Fairweather Dam on completion of the second lift, 1956.

Top, Hardy Dam, completed in fall, 1956.

Left, Hardy Dam during construction.

gate in order to regulate the flow of water during the spring runoff. Caland engineers worked closely with H. G. Acres & Company in the design of this water diversion scheme, with the consultants supplying water runoff information and designing the diversion, and the Caland organization doing field work and supervising the construction of the projects.

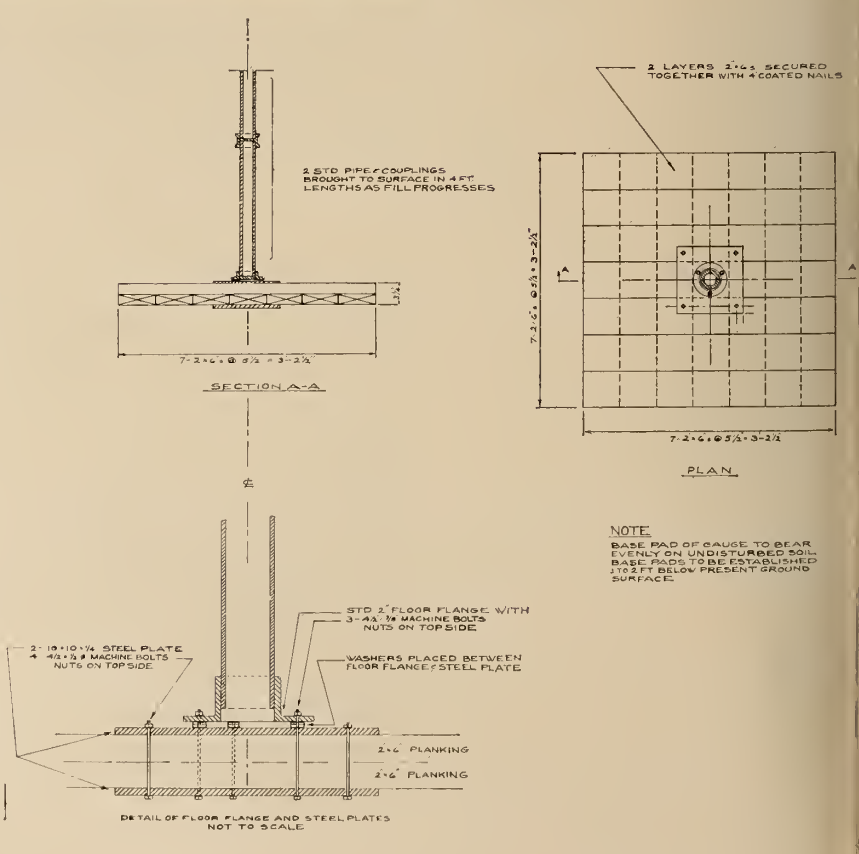
North of Falls Bay, water will be controlled by the South Twin Lake dam, also designed by the consultants; work on this dam is to proceed shortly. The South Twin Lake dam will be of concrete, and through it will be control gates to regulate the flow of water for the dredging program. When the dredging is completed in 1960, the dam will reverse the direction of the runoff in this area to the north, into Marmion Lake.

Another series of earth dams will be constructed in the area immediately east of Falls Bay. This area is known as Basin 'A' and derived its name when the early plans called for a series of eleven silt-settling basins rather than the one large basin in Marmion Lake. The main Basin 'A' dam is an earth structure and will prevent water from flowing through the old Seine River bed into Steep Rock Lake. It was through this area that the old Seine River flowed and was originally dammed up for power purposes before the Steep Rock project started.

There are three smaller auxiliary dams which will divert away from the main basin, by gravity flow into Marmion Lake, much of the water now flowing towards Falls Bay. The general area behind these dams is designated as Upper Basin 'A'. The remaining portion is known as Lower Basin 'A' and the water from this area will be pumped into Marmion Lake.

An extension of the Twin Lakes recharge control and the South Twin Lake dam, is the East Lime Bay recharge water tunnel. This project consists of a rock tunnel and an earth dam, and controls the water flowing into Falls Bay to supply the water required by the dredges. As the dredges remove the silt from the various lake horizons, the recharge water system will be extended.

As the Hardy dam is typical of the



Below, details of settlement gauge, Hardy Dam.

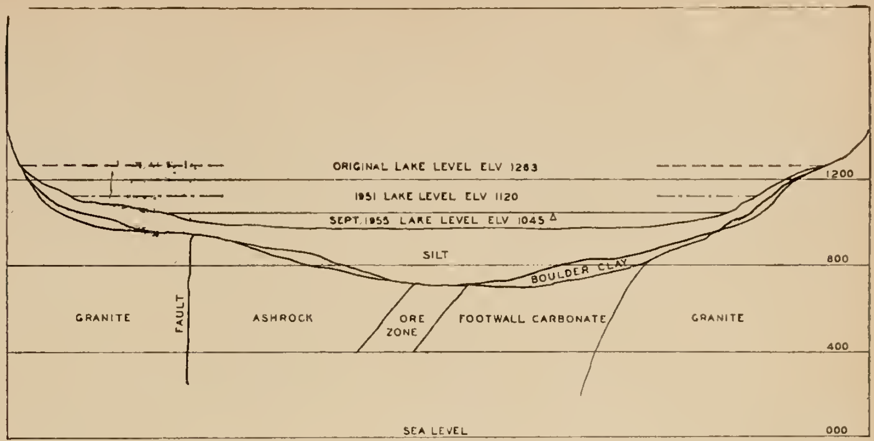
earthdams constructed for the Caland project, a short description of its design and construction history will give an indication as to the amount of planning and work involved in such a structure.

The Hardy dam is located at the toe of the south-east arm. Its embankment has a maximum height of 70 feet, is 1,190 feet long between ledge rock abutments, and has a toe-to-toe maximum width of 520 feet. The dam required one stage of construction and a total of 446,000 cubic yards of material to complete.

Early investigation of the dam site showed that the foundation conditions to be expected were quite different on the northerly one-third of the dam's length than it would be on the southerly two-thirds. North of Hancock Creek, the stream to be impounded and diverted, the ground presented a combination of gravel bed above ledge rock, grading to a stiff red clay. The natural ground on this side of the creek averaged ten to twenty feet higher than on the southerly side, which was represented by a flat lake bottom consisting of blue-gray clay with depths as great as forty feet.

Probe holes by hand augering and cased wash bore holes were put down to investigate the foundation material. Foundation investigations led to a design that provides a typical section for the north one-third of the dam, with an average terraced slope on the upstream side of one in two and two-thirds, and a down-stream slope of one in three. There is a short transition section to the southerly two-thirds of the dam which has both up and down stream slopes averaging one in four.

Construction specifications called for the embankment to be placed on one-ft. lifts compacted by multiple passes of a pneumatic-tired, 60-ton



Typical east-west cross section through Falls Bay.

Table I. Maximum Silt Production Figures

(from May 1955 through March 1957)

Period of maximum production	Period Day	Month	Year	Production (cubic yards) One dredge	Two dredges
One day	28	October	1955	149,310	—
One day	15	December	1955	—	253,895
One month		November	1956	2,498,540	4,583,030
One year	Jan. through Dec.		1956	20,204,530	39,600,530

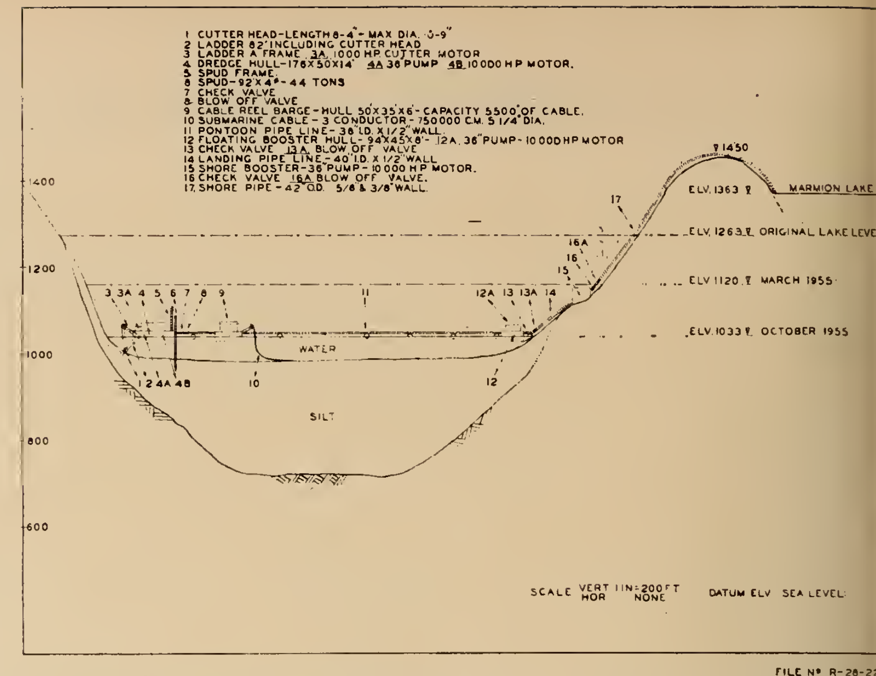
Below, left: an 18-wheel lowbed trailer hauling a 44-ton spud; the dredge "Joseph L. Block" ready for operation.

Right: monitoring operations at Falls Bay; section of the pipeline road and two 42-in. pipelines running between Falls Bay and Marmion Lake.

roller, with the adequacy of the compaction being determined by field testing to determine the Proctor dry density. Both top and bottom portions of individual lifts were checked to determine the extent of stratification. A high percentage of the results of the field checks showed a Proctor density in excess of 100%.

A peculiar consideration that had been taken into account in the design was the presence of two flowing springs in the north bank of the creak. The problem of handling this water was overcome by manifolding the flow through the fill to the downstream toe through 8-in. Armco perforated subdrain pipes encased within a prepared zone of selected pervious material.

Before starting to build the embankment, ten settlement gauges were positioned on the natural ground so as to provide three rows, each of which contains three gauges across the width of the dam, plus one isolated gauge near the northerly narrow end of the dam. These gauges were carried up with the fill, and consist of 4-ft. sections of 2-in. standard pipe built up from 3-ft. 2½ in. square base pads constructed of cross laminated 2 in. by 6 in. planks. The settlement gauge pipe column is secured to the base pad by a floor flange which is bolted to the upper of two ½-in. steel plates that are bolted together through the plank base. Rather than bolting the floor flange directly to the upper steel plate, the two were separated by ½-in. washers. This feature allows for seepage of water into the column so that the three rows of settlement gauges also serve as three lines of hydraulic gradient gauges through the dam.



A descriptive sketch identifying the facilities for excavating and moving the material from Falls Bay into Marmion Lake.

Individual graphs, depicting the data concerned with each settlement—gradient gauge, are maintained. Information on elevation of fill, settlement of original ground, elevation of reservoir, and elevation of water* in gauge, were kept on these graphs throughout the construction phase, and will be continued through and beyond the buildup of the reservoir and until settlement attains equilibrium.

After such earthwork projects are constructed, close checks on their condition are kept by regular readings of settlement gauges and piezometers set in the dams. The piezometer installations furnish information on pore pressures of the foundation clays and fill materials of the dam embankment, and are employed in the construction of the Fairweather Dam.

Plant site area at Falls Bay.

Dredging

On August 26th, 1953 a license of occupation was granted to Caland Ore Company by the Ontario Department of Lands and Forests. This gave Caland the necessary authority to construct the dams and controls to form a stilling basin for the fine clay material to be removed from the top of the orebody, and to start depositing the material into Marmion Lake after April 30th, 1955. At the same time, an agreement was reached with the Hydro-Electric Power Commission of Ontario for the construction of a power line from Port Arthur, Ontario, to Falls Bay.

After calling for tenders, a five-year contract was signed on September 28th, 1953, with the Chicago dredging firm Construction Aggregates Corporation (C.A.C.), to remove 160 million cubic yards of lake bottom material from Falls Bay. This target figure was later increased to 182 million cubic yards.

C.A.C. had previously done similar work in this area for Steep Rock

*In the original operating report on the Caland project, the plans called for all water controls to be under construction by 1956. With the completion of the South Twin Lake Dam and Basin 'A' dams in 1957, the major water control features will be finished well in advance of the initial dates set for mining operations.

Iron Mines Limited, and had wide dredging experience in other parts of the world.

In addition to the need for dredging equipment and power lines, a transformer station was required to convert the 115,000-volt power to 13,800 volts. Erection of the transformer station, as well as the construction of the Twin Lakes recharge control system, were scheduled to be completed before the start of dredging operations.

Plans called for the construction and completion of four items by May 1st, 1955. The North Marmion dams, transformer station, North Twin Lake recharge control, and two dredges were constructed on or ahead of time, so that on May 1st, 1955, the dredging program officially started.

The material to be removed from Falls Bay is a bed of silt, sand, and gravel with a maximum depth of 400 feet. The silt is in the form of a varved clay with light and dark bands and a normal colour of grey, with occasional areas of red clay. In some areas sand is mixed with the silt; in other areas, gravel has been washed in from shore on top of the clay. The moisture content of the clay is approximately 40% and is at the critical point of changing from a solid to a liquid. A severe shock, addition of moisture from rain or runoff, or additional weight can instantly change a bank of material from a solid to a liquid. Consequently the material is very treacherous and requires careful control. The varved clays are overlaid by several feet of organic mud, and underlaid by a gravel layer on the bedrock.

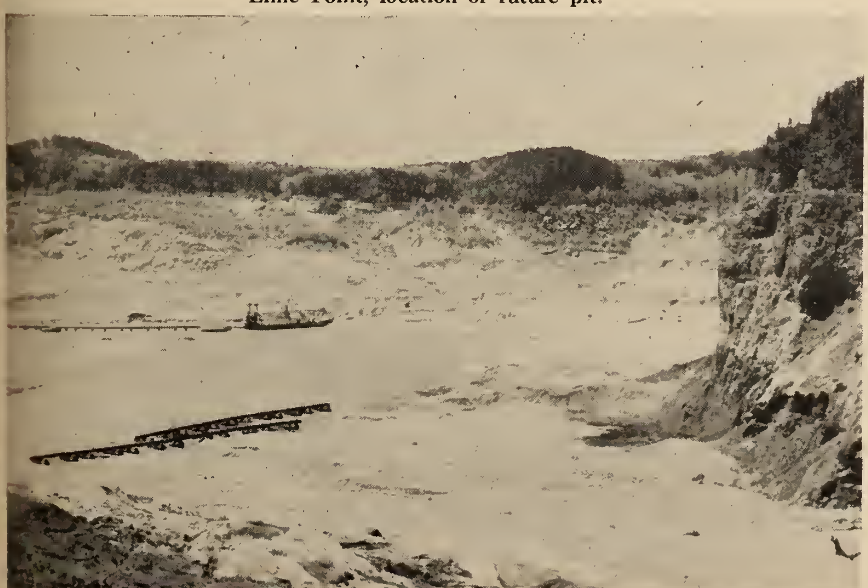
Mine plant area.

The dredging contract was set up in two phases; the "plant phase", and the "operating phase". The "plant phase" consisted of constructing the two dredges and the plant necessary to operate them. The second, or "operating phase", is the actual performance of the dredging operation, and is presently in its second year.

During the plant phase, a railroad siding was constructed at Steep Rock to handle the large amount of freight that was required in the construction of the dredges, and at the siding was erected a stiff-leg derrick capable of lifting a 75-ton load. All the material necessary for the entire plant was hauled over an arduous route — a winding 18-ft. wide gravel road, from Steep Rock to Falls Bay.

Buildings for shops, warehouses, garage, and offices, were erected at the Falls Bay site; the shore was levelled for construction of a dock, and work proceeded on the construction of the two dredges, *Clarence B. Randall* and *Joseph L. Block*, named after Inland's then chairman of the board, and president, respectively.

Lime Point, location of future pit.



On July 15th, 1954, the hull of the *Clarence B. Randall* was launched, followed by the launching of the *Joseph L. Block* hull on September 1st 1954. These dredges are the world's largest. Each dredge hull measures 176 feet by 50 feet by 14 feet; the pump on each is electrically powered by a motor with a rating of 10,000 h.p. The size of these units is emphasized by the fact that the power required to operate one of the Caland dredges is adequate to supply power to a community as big as the combined residential areas of the Lakehead cities, Port Arthur and Fort William.

Simultaneously with the construction of the dredges, the material along the shores of the lake was washed down by monitors, and the two 42-in. O.D. pipelines were laid over a road starting at the shore and stretching 4½ miles to the disposal outlet at Marmion Lake.

Early in March, 1955, the dredging project entered the operating phase of the contract, when the *Clarence B. Randall* began lowering the lake by pumping clear water. The project then passed through a shakedown period until May 1st, 1955, the official starting date of the dredging operation, when the *Joseph L. Block* pumped the first 19,700 cubic yards of lake bottom material which was deposited into Marmion Lake.

To March 1st, 1957, the two dredges have run approximately 67% of the available time, and have effectively moved material for approximately 50% of that time. The average volume of material removed per dredge is 3,500 cu. yd. per hour. On large equipment of this type, the effective operating time is expected to increase as the project proceeds.

At April 1st 1957, the two dredges had moved 60,378,760 cubic yards of material from Falls Bay, depositing it into Marmion Lake. Dredge production is greatly reduced whenever coarse gravel and sand is encountered.

Since the start of the dredging operation, the maximum productions that have been attained are shown in Table I.

Two identical dredges, two floating boosters, a shore booster and pipe-lines are the units which actually remove the lake bottom material. The dredges pump the material from the lake bottom to the floating boosters, the floating boosters pump the material to the shore booster, and this unit in turn sends the material through the pipelines to the settling basins in Marmion Lake. From here the recharge water passes back through North Twin and South Twin Lakes into Falls Bay, to make a closed circuit in the dredging operation.

The elevation of Steep Rock Lake in the Falls Bay area at the beginning of the dredging project was 1120 feet above sea level, having been lowered from the original lake level of 1263 feet by Steep Rock's drainage program. The elevation of the lake is now 965 feet, and the elevation of the top of the orebody varies from 1000 feet to 600 feet above sea level.

It is expected that by the fall of 1960, 182 million cubic yards of lake bottom material will have been moved and the dredging program will be completed.

To facilitate operations, an approximately 7-mile first-class highway has been built by Caland. This road connects the town of Atikokan with the plant area at Falls Bay, and considerably shortens the previous route which was by way of the Steep Rock property.

A pit road and several necessary branch roads have also been completed in the Caland plant area.

Mining

Because the top of the orebody varies in elevation, it will be possible to start mining in the north end before the orebody is completely uncovered. The general plan is that the first production of iron ore will come from open-pit mining; later in the program, underground mining will supplement the open pit, and ultimately the total production will come from underground.

The Inland Steel Company has operated iron ore mines since 1910. The Caland organization can therefore draw on this wide experience in iron mining for planning producing Inland's Canadian iron ore property. Caland also benefits from the Steep Rock Iron Mines operations in this area.

When the operating report was prepared, determining the justification for profitable mining at Falls Bay, estimated cost figures were used for complete mining of the orebody by underground methods. As a general rule, underground mining costs are higher than open-pit costs and it was felt that, if underground costs justified this operation, open pit costs would improve it. Later, when additional information about the orebody was gained, a study was made by open pit experts and it was disclosed that a portion of the orebody could be profitably open - pitted, which would justify the additional capital cost for open-pit equipment in addition to underground equipment.

At present plans are going forward for the construction of a 36-inch belt conveyor, in three flights totalling approximately 5,000 feet in length, to carry ore from the open-pit area at the north end of the orebody to the railroad loading station. This involves raising the ore from 900-ft. to 1380-ft. elevation, 480 feet vertically, and a distance of approximately one mile.

When the conveyor has been constructed it will be used at first to convey any gravel and sand that must be moved to uncover the orebody. Later it will convey the open-pit ore to the railroad cars.

In January, 1957, the first underground shaft was started. It is at Falls Point on the east shore of Falls Bay in the footwall granite, approximately 1,000 feet from the orebody. This shaft is designed for a capacity of 1½ millions tons of iron ore per year, and will reach full production in about eight years.

Three friction winding hoists (two skip hoists and one cage hoist) have been bought for this shaft from a Swedish hoist manufacturer.

The Caland project is planned to produce 750,000 tons in 1960, with full production of 3,000,000 tons in 1969.

To move these tonnages, the Canadian National Railway plans to construct a line from the Steep Rock spur to the Caland plant site. Much of the engineering on this phase of the project has been completed, and construction of the railroad spur should start shortly.

Close co-ordination of the mining program to proceed as the lake bottom is lowered by dredging will make it possible to start mining ore by 1960, and co-ordination of plans for open-pit and underground mining should allow a gradual and orderly increase to full production.

Aerial Survey Methods

(*Continued from page* 1656)

survey in any natural resources development.

(6.) Photographic interpretation is a useful aid in many lines of resources development, but it is not an end-all. The skilled interpreter must have a familiarity with his subject which can be gained only by close and regular work in the field. There are occasions, for example, when geological photo-interpretation purports to stand alone, doing away with field work. No geologist experienced in mineral exploration would accept such a premise. It follows that the terms "photo - geologist" and "photo-geology" express about the same limitations as "photo-farmer" and "photo farming".

(7.) The aerial survey methods and applications described in this paper are well suited to the vital parts they are playing in Canada's northward development. They will be relied upon increasingly in the future.

Of wider significance, these same methods are being exported to other under - developed regions of the world, as for example through the Canadian Colombo Plan surveys in various parts of Asia, Africa, South America, Australia, and even Antarctica are also receiving a large measure of Canadian-developed airborne survey. These methods are contributing in a very real way to the extension of improved living standard throughout the world.

The Authors — The contributors to this paper and their particular fields are J. F. Cunningham, forestry; I. S. Fraser land-use; J. S. Jenkins, economic planning; D. R. Lueder, engineering; R. N. Parkinson, geology; N. R. Paterson, geophysics; H. S. Scott, geology and geophysics. Mr Scott, technical director of the company compiled and edited the contributions.

A Review of the DEW Line

Most people are now familiar with the story of the Distant Early Warning Line, its original planning and the security purposes for which it was built.

Basically the DEW Line consists of a number of radar stations spaced strategically along a 3000 mile line north of the Arctic Circle between northwest Alaska and the east coast of Baffin Island; it is a radar fence, composed of three types of radar stations — main, auxiliary and intermediate. Main stations are the largest, contain the most electronic gear, and operate as control centres for rearward communications, transportation, administration and maintenance. Auxiliary stations, although functionally similar from an electronics viewpoint except for rearward communication links, are considerably smaller and do not require administrative and other specific facilities of the larger stations. The intermediate stations are still smaller and are substantially automatic electronically.

This article has been prepared by arrangement with the Western Electric Company Inc., New York, the designers of the original equipment, and with *Engineering and Contract Record*, who published a series of three articles based on the original material (June, July, Aug., 1957). The authors who wrote the complete material were M. S. Cheever, supt. construction, J. D. Brannian, asst. supt.-siting engineering, and C. W. Walker, asst. project mgr.-construction siting, all of Western Electric Company Inc. Above is an aerial view of a central section main station showing 250,000 gallon site tanks in foreground, building trains, radome and construction camp; garage is in rear and construction of the 30 ft. parabolic antennas is in progress.

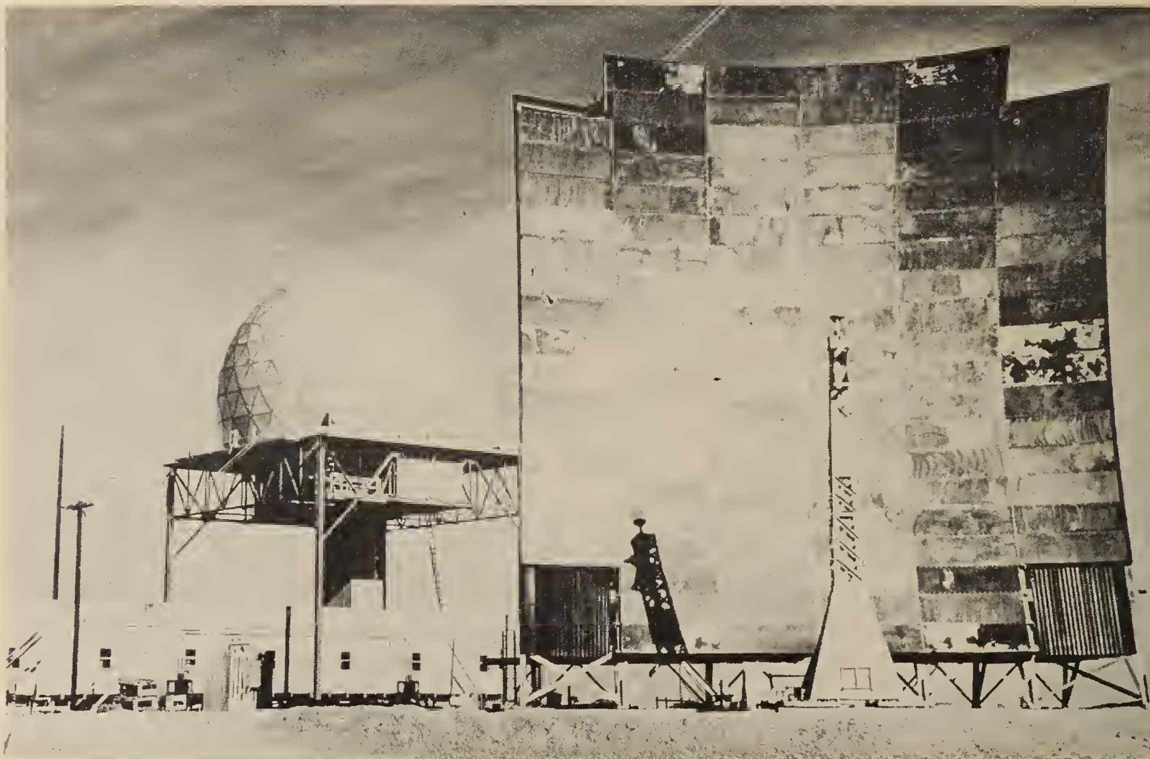
The story of the DEW Line is fantastic. This full-scale attack on the Arctic is unparalleled in military construction history, and its building is an unending tale of adventure and pioneering in engineering, electronics, transportation, construction, and operation. It is the story of a vast project of coordination between U.S. and Canadian civilian and military personnel — of shipping materials by land, sea, and air under the most strenuous conditions — of construction and field engineering forces performing under the most adverse weather conditions imaginable.

The work associated with the DEW Line is a supreme challenge to the scientist and designer, and a fascinating project to the construction engineer. The factors in working in a new frontier flavour a comprehensive variety of work embracing earthwork in roads, airstrips, storage areas, and building pads; pile, timber, and concrete foundations; modular electronics buildings and steel framed garages and hangars; a dozen types of antenna including those mounted on poles up to 80 ft. high, huge parabolics mounted on rigid and guyed towers, other parabolics so large that they had to be designed as an integral part of the structure, and wire array corner reflectors supported on an array of nine towers; new radar antennas enclosed in a newly designed rigid, super-sized radome; and numerous types of outside cabling for antenna leads, communications wire, power distribution, and airstrip and obstruction lighting. And the job would have to be duplicated practically many times, all concurrently.

In viewing the DEW Line from the construction viewpoint, it is not possible to exclude operational planning, engineering design, siting or logistics. Much has been written concerning construction for the Arctic. However, no one treatise sets forth in practical terms an outline of extreme conditions to be encountered from Bering Strait to Baffin Island. The conditions are encountered in four years of DEW Line operation in Alaska and two years in Canada and their description will be confined to fact and observation of their effect on DEW Line construction.

Terrain

The DEW Line traverses everything from flat Arctic plains to glacier-studded peaks. The coast of Alaska is flat tundra with highly frost-acting soils. Limited deposits of sand and gravel are scattered along the beaches. In Yukon Territory the country assumes a rolling character with hills up to 500 ft. The flat swampy terrain of the Mackenzie River Delta consists of soils of silts and fine "blow" sand,



A 60 ft. parabolic reflector with completed radome in background; note tower guys between the two structures.

all frost acting. Gravel deposits are few and small. From Cape Parry to Rae Straits the land, occasionally flat, is usually rolling and features old raised beaches and outcrops of dolomitic limestone. Gravel is abundant.

Logistically, this territory can be resupplied by naval convoy from the west coast. Support is also practical via the Mackenzie. From terrain, logistic and geographical considerations, this area was divided at the Alaska-Canada boundary into the western and central sections of the Line. The third eastward to the Davis Strait became the eastern section.

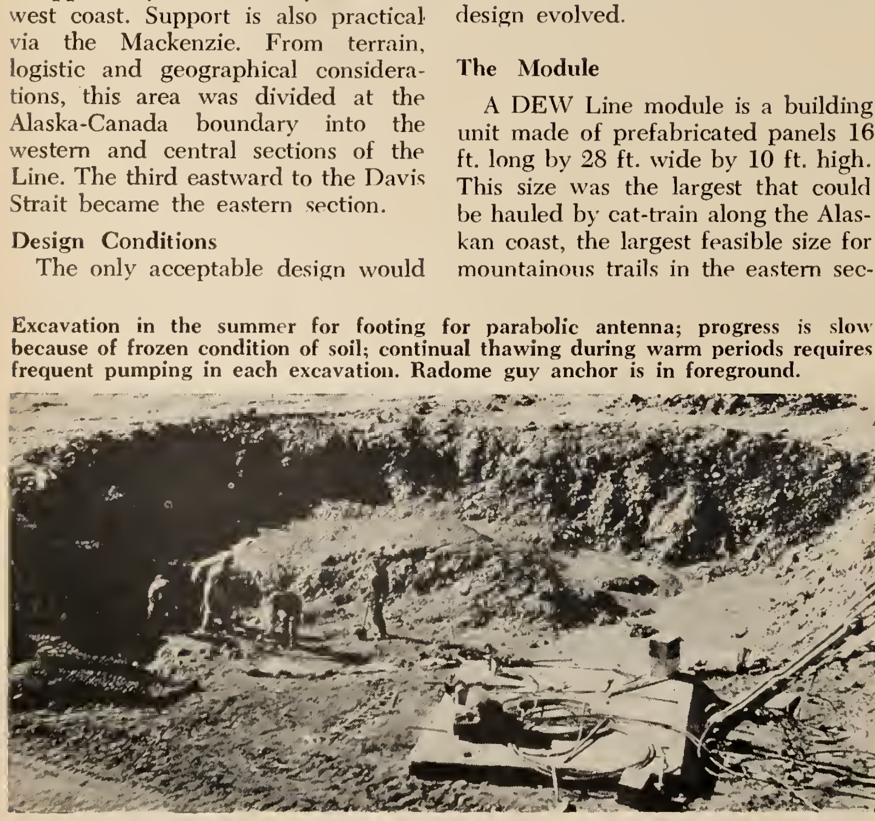
Design Conditions

The only acceptable design would be one which would permit the start of construction of buildings ahead of, or concurrently with, the general development of the site. Such a design must embrace the concept of constructing units of the building at one location and transporting them to their final location. Thus a modular design evolved.

The Module

A DEW Line module is a building unit made of prefabricated panels 16 ft. long by 28 ft. wide by 10 ft. high. This size was the largest that could be hauled by cat-train along the Alaskan coast, the largest feasible size for mountainous trails in the eastern section, and the heaviest load that would be handled onto and off sleds. The modules have a door in each end so that when placed in position end to end a continuous long building 28 ft wide is formed with the doors in alignment for a corridor for the full length. This assembly of modules was informally christened the "building train", and it was designed to house the power electronic and heating plants, living quarters and mess, with a module structural strength to withstand the stresses of hauling over rough terrain. The use of prefabricated metal in this panel was ruled out because of electronic considerations with the resultant wood frame and plywood design being a type that could be produced by any well equipped wood fabricator. Thus production bottlenecks were avoided by permitting simultaneous fabrication of panels by several firms all using the most readily available building material: wood. Production was by Timber Structures, Inc., Portland, region Sigurdson Millwork Company, Ltd. Vancouver, B.C., Tower Company Ltd., Montreal, and Hill-Clarke-Francis, New Liskeard, Ontario. With this design, the contractors were afforded the option of fabricating at a central location for distribution to sites later, fabricating at the sites for placement on foundations to be made ready later on or construction in place on completed foundations.

Excavation in the summer for footing for parabolic antenna; progress is slow because of frozen condition of soil; continual thawing during warm periods requires frequent pumping in each excavation. Radome guy anchor is in foreground.



The installation of mechanical and electrical work was difficult and complicated due to restrictions in room and penetrations through module walls. One design requirement imposed by equipment engineers was that the train had to be shielded from penetration by radio waves and that the equipment spaces be shielded inside also. As shielding was accomplished with a built-in copper screen sheath, the modular design imposed more work. This was particularly true at the connections between modules for this and other work since the modules are placed 6 ins. apart and this space is filled with a vermiculite fire barrier. Details for weatherproofing this connection, retaining the vermiculite, and placing of pipe sleeves all made for extra effort that would not have been required in a single building.

Styroflex cables to 30 ft. parabolic reflector and guyed tower are covered with gravel and marked with empty oil drums. Note corner reflectors in rear. Foreground building is a Simpson hut, while those to the rear are framed tents.

Foundations

The modules were designed for placement on a foundation which would set the floor about 4½ feet above grade and leave a blow-through under the train. The first advantage was that connection under the building assures that no heat loss will transmit into the soil to upset the thermal balance of the permafrost and cause foundation settlement. Secondly, the drifting is alleviated and the snow removal effort reduced. Third, access to the building underside is desirable for the future placement of cables. This was important because it was not possible to engineer all cable penetrations until months after many modules were placed.

Basic foundation design for DEW Line modules trains was a trestle arrangement of short posts with sills and caps, all of timber. The sills were placed on a non-frost acting gravel. The minimum depth of fill from 18 ins. to 4 ft., depending on the soil type as test pits determined. The adequate depth allowed assured that the non-frost acting fill would provide insulation to keep the soil frozen to prevent settlement. At some sites where the natural grade was very irregular, fills were up to 18 ft. This was done in lieu of a vertical stagger in the 400-ft. long train so that the future maintenance penalties would not accrue in the form of snow drifting and awkward grades for vehicles servicing the site. The sills were eliminated and the posts secured directly to solid rock where it existed. This was a concession to save gravel haul, particularly where the site was far from the source, but occurrence of satisfactory rock under the sited locations was disappointingly small.

Enclosure for the 60 ft. parabolic antenna is being completed under winter conditions; the foundation for a similar unit stands ready for the start of steel erection.

A third type of foundation design was employed at the west end of the line where the soils were mostly frost-acting silts and clays with ice lenses. Instead of the posts, sills, and gravel pad, wooden piles were set in the frozen ground, and capped with timbers. This design provided the best assurance against settlement in this soil condition, and saved thousands of yards of extremely scarce gravel. In setting these piles, holes were first steamed or drilled to depth in the frozen soil. The pile was placed in the hole and tamped (sometimes light driving was required) to make certain bearing was obtained on the bottom of the hole. The pile was then braced or weighted for alignment and flotation prevention while the hole was backfilled. Steamed holes were wet and so dry sand was used. Holes drilled in freezing weather stayed dry and were backfilled with a sand slurry for a frozen bond between soil and pile.

Wherever piles were utilized for module foundations, they were also used for the site garage. Pile clusters with concrete caps supported a structural slab above grade as well as the superstructure. This maintained a "blow-through" under the slab which inhibited heat transfer to the soil. At other sites a gravel pad was placed for the garages and spread concrete footings used for bearing under columns. The same structural slab as designed for pile footings was utilized but here it was poured on the fill. The depth of fill was increased to provide more insulation in lieu of the "blow-through."

Hangers were supported on concrete perimeter walls with footings extending well below finished grade into the gravel fill. No pavement was provided inside the hanger for reasons of economy as DEW Line hangers were designed primarily for emergency shelter, not full operational aircraft maintenance. The gravel pad was designed thick (up to 12-ft. minimum for some soils) to provide insulation for subsoil against hangar heat.

Bulk storage tanks for P.O.L. were generally placed on gravel pads except where gravel supply was critical and piles were utilized.

Guyed towers up to 200 ft. were supported on piles and special "frozen-in" guy anchors were used. Utilization of piles for this purpose saved difficult excavation of frozen soil and costly concrete pours. For taller towers and where soil conditions would not permit the use of pile concrete footings and mass anchors were employed. Excavation for these footings was done practically on a year-round basis and extreme care had to be taken with concrete. Even in the summer, the condition of frozen soil constitutes a hazard to a concrete pour. Freezing the concrete is possible or the heat of hydration can thaw the soil and cause settlement. The designers provided protection against this condition by specifying a 4-foot gravel lining for each excavation. While this required additional excavation beyond the neat or nominal footing size, it helped in summer to keep the soil in its frozen state while forming and setting steel.

The foundations for rigid towers supporting 30-ft. dia. parabolic reflectors were of a similar design to those for guyed towers. Piles were used wherever practicable, the major difference being that steel pipe was specified to meet the need of a material with tensile as well as compressive strength to resist overturning. Special lugs were provided on all such piles for anchors to resist withdrawal. Pile clusters had grillage caps of structural shapes welded in place. Steel piles were never used for support of any (heated) structure because of the danger of the steel conducting heat.

Special erection tents were provided so that module fabrication could be sheltered from inclement weather. The modular design permitted certain elements of mechanical and electrical work to be started before the module was permanently located. End wall of this unit has been left out pending installation of a water tank. Future replacements of major units in the train are facilitated by the ability to remove complete walls in this fashion.

Garages and Hangars

Being less associated with electronic gear, greater latitude in using metal was permissible for garages and hangars. The panels on these structures had an aluminum outside face with steel on the inside. Wood panel framing members (pre-treated with fire-retardant paint) prevented thermal conductivity between faces. Interlocking male and female edges were precaulked to provide a weather seal and the fibre-glass insulation was contained in hermetically sealed bags to preclude deterioration by water vapour.

A structural bolted steel frame was utilized for these buildings to which the panels were secured by lagging through holes in the structural steel into the wood panel frames. Garage doors were of the overhead type while the hangar doors rolled on steel rails. All door leaves were fully insulated.

Radome

As of 1955, only one structurally successful rigid radome was erected, and was still under test by the Air Force in Greenland. Geodesics Inc. (the designer), Western's engineers and buyers, the Bell Telephone Laboratories and four manufacturers tackled the job of developing tools, techniques, and materials for the mass production of this radical structure. There emerged in quantity 16 shapes of lightweight translucent panels which when assembled in the sequence and number provided a successful spher of more than 50 ft. in diameter. So clever is the design and the special erection gear that 20 men can erect one on the high platform in les than half a day.

Mechanical and Electrical Design

The logistic concept of operating the DEW Line with a minimum number of people results in the design of the greatest practical application of automatic controls for mechanical and electrical apparatus. Such an installation put the contractors to the acid test of co-ordination of build

Module on sled is being towed by a D-8 tractor.

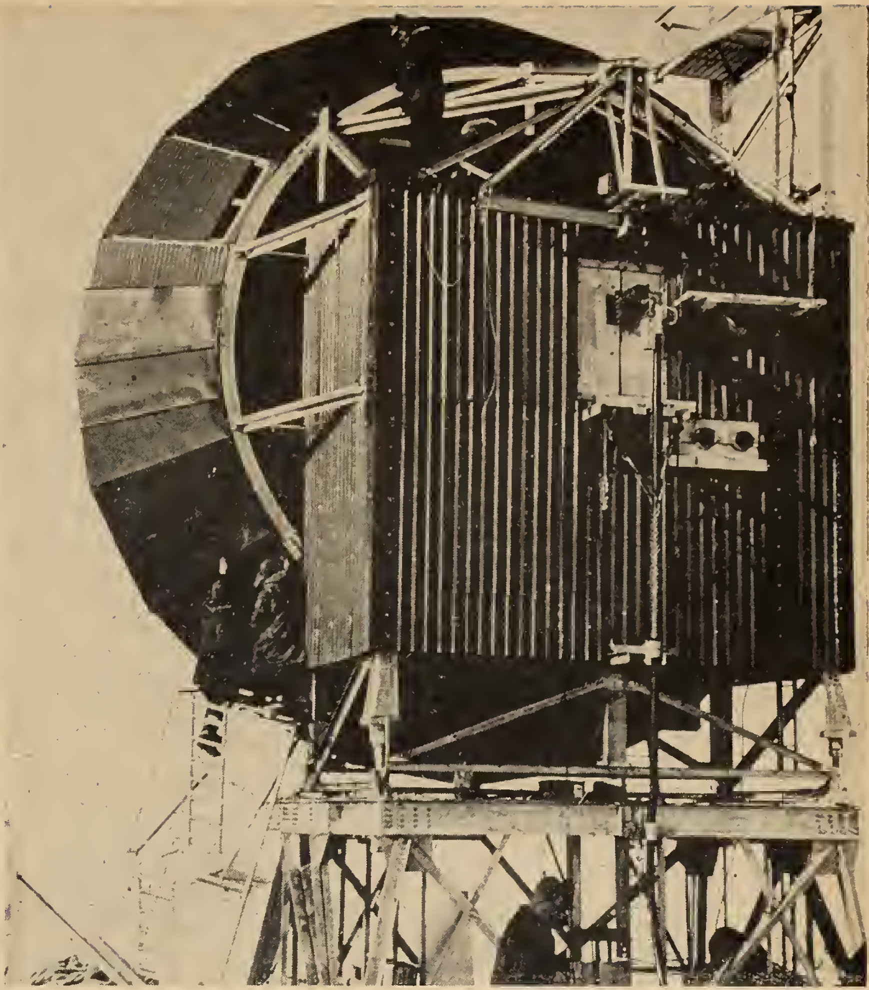
ing trades and any related problems were magnified in the close quarters of the "Pullman type" space. Though the equipment and materials employed were commercially standard, the application was not always so. For example, heat reclaimed from the jacket water and exhaust gases of the diesel generators becomes the normal source for the entire train. This heat is made available automatically by control of dampers on cooling air, 3-way valves on engine water jackets, and valves on parallel exhaust stacks.

Importance of Airstrips

Access to DEW Line sites is basically by two forms of transportation. Most locations can be reached by water during a summer period from either the east or west coasts or via the Mackenzie River. Support of the Line, week in and week out, necessitates reliable air transport service. The first objective was to build an ice strip. In some areas the ice was blown relatively free of snow and it was only necessary to knock down a few small drifts by hand to permit the landing of wheeled aircraft.

It was desirable that construction of the permanent gravel strip should begin immediately where possible.

At many locations, construction expediency demanded that the permanent site location be established in order to prepare a usable strip at the earliest possible time. The western sections made out in this respect by close margins due to the limited gravel supplies available in the late spring and during the summer. The central section was blessed throughout most of their area with conditions which enabled them to have an excellent strip at all locations except two in the Mackenzie Delta area. The eastern section had no difficulty in the Foxe Basin area, but their inland sites, not accessible by sea, and the Baffin Coast sites ran into trouble. Their work was hampered by extremely rugged terrain and limited gravel deposits. A number of sites that could not develop strips by the end of June were isolated for a period of about six weeks until the ice opened up sufficiently to permit service by amphibious aircraft. At times food and supplies ran so low at some sites that support had to be provided by air drops. It was not until early fall that all the designated airstrips were established and some of these were merely graded areas on frozen ground. Progress at each site could almost be measured by the air service rendered it.



Finishing touches to the de-icing enclosure and heat system are being applied to this 30 ft. parabolic antenna in the eastern section.

Rime ice on guyed tower late in 1956.

1955 Achievements

Once established on site each contractor faced the development of facilities needed in the course of his program. The first housing at most Canadian sites consisted only of tents. Then came Atwell huts — an insulated canvass covering over wood arch ribs with a plywood floor, housing six men and heated with a 75,000 B.th.u. space heater. After the sealift, the Simpson hut was developed; this was similar to the Atwell with ribs formed over short pieces of dunnage lumber scabbed together, covered with tarpaulins; the lining was sisal kraft paper and corrugated packing paper provided the insulation.

Each auxiliary and main site was equipped with a steel framed building covered with tarpaulin or plastic fabric sufficiently large to permit the assembly of complete modules inside. Where module fabrication continued into winter months, heat was provided by a hook-up of a Dravo heater from a garage or hangar.

The nucleus of the Western camp was the wanigans from the cat trains. These units were kitchens, mess halls, wash houses, water storage (heated) shop, power or bunk houses. One was also office and radio shack. With this equipment, a 50-man camp could be in full operation with the arrival of the eat train at a site. When a gravel pad had been provided for a permanent camp, facilities were expanded using tents and huts.

Experience proved that where there is reliable camp power, a domestic hot-air furnace with electric blower and burner is more efficient than the pot type space heater, and requires less maintenance.

First business at each site occupied in the winter was the ice strip. Aside from improvement of the construction camp, the next was invariably to initiate a search for gravel for the permanent airstrip.

Before the year end roads had been pushed up hills to the sites at a number of the locations in the East. With the placement of a minimum pad, timber foundations were constructed in the failing light often with the aid of flash lights for levelling. When this work was complete modules were towed up and set in place.

1956 Achievements

Spring saw foundations for antennas, both pile and concrete, being placed. Sites isolated the previous summer from their gravel were busily hauling around the clock across ice and tundra. Eastern section was moving the last of its modules up tortuous mountain roads and relocating construction camps closely to the sites. Northern Construction Company was reopening "I" sites closed for the winter and proceeding with all phases there.

The structural steel for towers was successfully delivered in western and central sections. A substantial amount was also reached in the eastern section sites but the first of a series of adversities entered the picture at this point. Certain jobs depending upon ice strips for steel deliveries did not receive the complete shipment. This was mainly attributable to very poor flying conditions and, in lesser degree, to logistic problems pertaining to material handling. Extremely heavy runoff was experienced in June and many roads from strips to sites were temporarily closed or usable for only the most urgent service requirements and then under restricted conditions. As soon as strips and roads became usable again the equipment was employed to haul concrete aggregate needed for tower foundations, and then the third piece of adversity struck. Many of the earth fills which had been placed during the previous winter under garages and modules began to settle due to inclusion of snow when pads were being constructed. The earth hauling equipment now had to give up hauling vital concrete aggregate and concentrate on repair of the existing pads.

In spite of these problems, progress was continuous and by the end of the year beneficial occupancy of all sites in the central and western sections had been assumed by USAF. Beneficial occupancy in the eastern section occurred in the early part of 1957 and construction schedules were reoriented during the winter so as to make allowance for completion at a later date of that portion of the unfinished work which was not essential to the operation of the stations.

At the close of the first half of 1957 there were but a few outstanding deficiencies across the line. Major components of the remaining work involved are airstrip and road improvement in the eastern section and at one site in the central section where gravel must be hauled up on improvised skipway from a beach to the top of the 400-ft. bluff. Several service facilities, such as garages and hangars, are still being constructed together with odds and ends of antenna heating, airstrip lighting, and miscellaneous outside plant.

It seems impossible today that a multi-million dollar radar station that is now perched on top of a 2000-ft. crag north of the Arctic Circle was 33 months ago only a single line diagram on a piece of paper; 27 months ago, just so many tons of freight; 21 months ago, a few survey stakes five miles above a tent camp; and 15 months ago a collection of unassembled, disconnected buildings. Yet this performance has been duplicated at all specified locations from the Davis Strait to the Bering Strait as a monument to the engineers' vision, the contractors' ingenuity and the will and goodwill of North American neighbours.

The completed site atop a Baffin Island crag gives a breath-taking view of Arctic scenery.

DISCUSSION

of Technical Papers and Other Articles

ENGINEERING THE R.C.A.F. ARGUS

William K. Ebel and Everett B. Schaefer,
The Engineering Journal, 1957, *July*, 967

Mackenzie McMurray[1], M.E.I.C.

Mr. Schaefer has presented a most interesting paper or a rather unusual phase of engineering in Canada.

It is obvious that the authors have had a struggle with the security regulations but have succeeded in giving us a glimpse of the many problems involved.

My discussion will be in the form of a few questions.

(1) In re-engineering the Britania many man-hours of engineering talent have been spent. In many instances when one tries to re-work a problem of this sort one finally spends more hours than if one had started from scratch. I would like to know some of the reasons involved in this decision and roughly how it compares with an estimate of producing a new aircraft. Or in other words, what were the main advantages of using the Britannia.

(2) The authors have mentioned rather briefly the elaborate test programs set up for the various systems such as electrical, hydraulic, etc. in use in the aircraft. The re-design of the electrical systems was a major program and some amplifications would be of interest.

(3) The use of a piston-type engine instead of the turbo-propellor type is explained due to the service required in this particular case. However, was this a re-vamped design of an existing engine or was it engineered from first principles by Canadair?

(4) A good deal of effort seems to have been spent to comply with the R.C.A.F. regulations in regard to natural specifications. Is there any standardization program being contemplated by say Britain, Canada and the United States?

The authors have mentioned the testing programs carried out on the components of the various systems in the aircraft. I would like to comment that I had the privilege of visiting the plant a few weeks ago and I was amazed at the extent of the work carried out in this area. Very little has been left to chance as so many of the problems have been worked out on these ground installations long before flight testing.

This paper describes a relatively new field of engineering in Canada but a most important one in view of National Defence. Canadair are to be complimented on their efforts and on this job in particular when one recognizes this adherence to the original schedules set up for the production of this important aircraft.

[1]Assistant to the Vice-President and Managing Director, Dominion Bridge Company Limited, Lachine, Que.

Group Captain C. W. Crossland, M.E.I.C.[2]

A comment which I might make on the paper, "Engineering the RCAF Argus" by W. K. Ebel and E. B. Schaefer is that the authors' remarks concerning RCAF requirements governing the design and material standards for the Argus might give the impression that the "Manual of Aircraft Design Requirements for the Royal Canadian Air Force" forbids the use of British standards and material specifications. Although this publication gives preference to Canadian and U.S. standard parts, it does not exclude the use of materials conforming to specifications published by the Ministry of Supply and the British Standards Institution. Availability in Canada or the U.S. is the over-riding consideration, since it is desired to be as independent as possible of overseas sources of supply of spares for military aircraft.

[2]Assistant for Standardization, R.C.A.F. HQ., Ottawa.

A MAJOR POWER PLAN FOR YUKON RIVER WATERS IN THE CANADIAN NORTHWEST

J. M. Wardle[1], M.E.I.C.
The Engineering Journal, 1957, *November*, 1638

G. V. Eckenfelder,* M.E.I.C.

As the more accessible sources of hydro-electric power in Canada are developed, and their output utilized, established industries must find other sources of power to meet their requirements. There remains in the country, however, a number of large power sites which are situated beyond a practical transmission distance of the present load centres. Development of these sites can be of use only to new industries established near them. For this to be possible, the new industry must be one which does not rely on cheap transportation or, alternatively, the site must be accessible to ocean shipping. The scheme which Mr. Wardle has outlined fulfills the requirements of the latter. A tremendous power potential exists in the upper reaches of the Yukon River watershed, so situated that generating plants making use of this potential can be located within a short distance of a site which can accommodate a large metallurgical industry and which, at the same time, is readily accessible to the sea.

Mr. Wardle has described the extent of the investigations being done to determine the best way of developing the power available, along with a study of the related problems of locating sites for industrial development, methods of transportation and sources of raw materials to be processed by using the available power. He has also indicated the amount of studies and investigations remaining to be done before the project can become a reality. The international ramifications are not by any means the least of the problems to be solved, and their solution will require wisdom and foresight.

This paper is timely as it discloses one more instance of the vast amount of work which is in progress to open our north country to development, and to the production of wealth.

* Montreal Engineering Company Limited, Montreal.

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

THE SOVIET ENGINEER AND HIS ENVIRONMENT

E. P. Ward, *Engineering*, v. 184, No. 4775, Sept., 1957.

This is the first in a series of articles dealing with Soviet engineers based on a recent visit made to Russia by the author, a deputy editor of the British publication *Engineering*.

To what extent do engineering products enter into Soviet life? As would be expected, Moscow and Leningrad are modern cities; the streets are crowded with motor-cars, sometimes of good contemporary styling, with a considerable sprinkling of elegant single-deck trolley-buses. A high proportion of the cars are large, suggesting that many are employed by officials rather than by private individuals. Further evidence that private ownership of road vehicles is rare is given by the small number of bicycles and motor-cycles to be seen on Moscow streets and in the country although one factory visited produced bicycles as a sideline at the rate of two per minute (460,000 a year). Trams are still in use in Leningrad and in the outer parts of Moscow; street lighting is adequate, though not brilliant, and broad avenues minimize traffic bottlenecks.

Rail travel can be extremely comfortable with well designed and equipped sleeping compartments. A 5 ft. rail gauge and a 16 ft. width of loading permit generous carriage dimensions. Three trains run approximately simultaneously between Moscow and Leningrad several times a day, and to avoid the reactionary distinctions of first and second class, the coaches are denoted "soft" and "hard". Long distance trains are frequently steam-hauled, though Diesel and Diesel-electric locomotives are in use. A gas turbine locomotive is said to be under development as well as a gas-turbine plant for marine propulsion. It is claimed that a 3-hour service between Moscow and London by the Tu jet aircraft will operate next year. Housing shortages in Soviet cities are a serious problem although all around Moscow vast building projects are under way; large numbers of apartment houses of closely similar design are to be seen in various stages of completion. Non-condensing steam turbine plants (25 Mw.) are in operation as sources of power and secondary steam for process and district heating. A 50 Mw. version to supply areas 5 km. in radius is also in production. Even before the war Moscow had a stereoscopic three-dimensional cinema. Television is clearly very common, though presumably only in the main population centres. Excellent long-playing records are sold at a price half, if not a quarter, that obtaining in the United Kingdom.

It is already well known that Soviet engineers occupy a high place in their community. Relative salaries provide a useful indication. A young diploma engineer, for example, will earn at least 880 and probably 1,000 roubles a month, which is equal to the salary of an experienced interpreter or a middle-school teacher. (£1 sterling on a trading level is equivalent to 11 roubles). The lowest wage for a semi-skilled factory worker is about 650 roubles per month. The average monthly wage for workers in a particular automobile factory is 900 roubles; while in the same factory the average salary of engineers is 1200 to 1300 roubles, but with the upper grades receiving in charge of a shop may earn 2000 roubles, and the head of a factory or research institute between 4000 and 6000. A doctor of science is entitled to 1000 additional roubles a month and a candidate of science, the next lower degree, but above the qualification of diploma engineer, 500 roubles a month. The head of the heavy-machine building institute, who is a doctor of science, earns 6000 roubles a month; he remarked that he had recently visited England and that his opposite number there seemed to have roughly the same living standard. A teaching professor of medicine would earn about the same. There are also bonus payments in cases where a norm is exceeded. A guide to the purchasing power may be gathered from the following prices —1 lb. butter 10 roubles, 1 lb. apples 1 to 3 roubles, a suit of clothes 300 to 1200 roubles, a car 15,000 to 20,000 roubles, a long playing record 10 roubles, an upright chair 10 to 30 roubles.

The status of an engineer is likely to reflect his value to society, and his value will depend on the use that can be made of him. How profitably are engineers employed in the Soviet Union? Are they sometimes wasted? When an engineering student obtains his diploma he is normally directed to appropriate employment but if the post proves to be unsuitable he can choose a new appointment. Nevertheless, the rate at which engineers are produced and the tendency, whatever the job, to prefer an engineer to a technician, and a technician to a craftsman, must lead to some misplacing and under-utilization of qualified men.

There is a remarkably high proportion of engineers on factory staffs and it underlies the extent to which research and development is carried on in factories. Examples of the percentage of the total employees of various factories, who are classed as engineers, technicians, and draughtsmen are: bearing factory of 10,000 people, 4.5 per cent; special steels plant of 10,000, 10 per cent; motor vehicle factory of 40,000, 15 per cent; and a machine tool research institute of 2,450, 35 per cent. In a turbine factory employing 11,500 persons 8.7 per cent are classed as engineers and 17 per cent as technicians and draughtsmen; in an electrical generator factory of 6,000 the figures are 17 per cent and 33 per cent. It is clear from these figures that the term diploma engineer in the Soviet Union has a somewhat different meaning from engineering qualifications in Britain, but the extremely high percentages are nevertheless of great interest. As a basis of comparison the number of professional engineers, diploma engineers, and holders of Higher National Certificates in selected British industries can be given as percentages of total employees. Thus, in the electrical industry there are 2.8 per cent; in the iron and steel industry 0.65 per cent; and in the motor vehicle industry 0.87 per cent. It is significant that the Soviet electrical factory likewise has the highest percentage of technically qualified employees. Foremen are frequently diploma engineers but non-formally trained men often hold positions of greater responsibility than diploma men. It is of interest that university lecturers and professors often serve as consultants to industrial firms. Also noteworthy is the considerable proportion of diploma engineers who are women. The Soviet Union almost manages to double its labour force by the widespread use of female labour and the provision of creches for children. Often the care of children is the responsibility of the factory. Of the 450 engineers and technicians at the First State Ball Bearing Factory, some 40 per cent are women, working mainly in the estimating, costing, and work-study departments. The majority have diplomas in engineering economy, which are of comparable standing with engineering diplomas and awarded by an Institute. At the Electrosila factory in Leningrad, 300 of the 1000 diploma engineers are women.

Post-diploma studies are generally carried out in the evenings, but for those able or willing to sacrifice their incomes, day courses are also provided. To encourage the engineer to continue his education, there are a series of further qualifications. On obtaining his diploma he must complete three years of useful work, following which he can become an "aspirant" by joining a special school. There he spends two years preparing for examinations and a third working on a thesis. At the end of the third year he presents his thesis and defends it publicly before a scientific panel. If successful he becomes a Candidate of Science, the first engineering degree. The Candidate may then prepare a doctor's thesis on some salient problem (e.g. the design of industrial rolling mills), presenting it after perhaps five or ten years to become a Doctor of Science.

IGY IN ANTARCTICA

Two members of the U.S. Navy's expedition to Antarctica take advantage of a pause in a journey to collect snow for water in a dining "wannigan", which is mounted on one of 38 sleds equipped with runners fabricated from alloy steel. The 11-ton sleds, capable of carrying loads up to 20 tons, were used to haul supplies needed to establish six observation bases for the 1957-58 International Geophysical Year. (Photo: United States Steel Corp.)

EDUCATION AND TRAINING FOR THE ENGINEERING INDUSTRY

Sir David Anderson, *The Engineer*, v. 204, No. 5303, Sept. 1957.

Engineering is the most widespread and basic of the British manufacturing industries. Not only is it a major industry in its own right, but practically every manufacturing industry depends on engineering for the design, operation and maintenance of its plant and equipment. The whole industrial prosperity of the country is linked to the ability to organize and maintain a highly efficient engineering industry.

Government sources have estimated that the need for engineers and scientists will be doubled in the next 10 or 15 years and that this is a minimum goal if the economy is to grow at an acceptable rate. This means about 20,000 trained persons produced per annum and is a figure not likely to be reached. The accelerating pace of economic and technical change is such that there will be a shortage for many years to come. The diversity of activities and multiplicity of professions in our modern way of life are such that, at the higher levels of intelligence there is simply not enough manpower to go round. In industry the most urgent need today is not for more scientific discoveries but for a wider and more intensive application of discoveries already made. Every scientific discovery opens up a fan of potential applications, and the engineering industry will be able to absorb for a long time ahead all the recruits it is likely to get.

From all the information available it seems that Russia, the United States, Western Germany, and Britain are producing technologists, mostly engineers, in the ratio of 4:2:2:1 per unit of population. It is more than a little disturbing that Western Germany, which has the same population as Britain, is at the same stage of industrial development, and is also heavily dependent on exports, is producing twice as many technologists. This may be a highly significant factor when the European Market comes into operation.

At the lower levels of employment in the engineering industry there

BERKELEY NUCLEAR POWER STATION

Construction of the commercial nuclear power station at Berkeley, Gloucestershire, England, will eventually use over 70,000 tons of cement. The two main civil contractors have erected weigh batching plants to provide most of the concrete required. The plant shown above incorporates a 150 cu. yd. bin, split into two compartments to hold two different types of cement used. Below the bin are two 2000-lb. capacity weigh hoppers, two aggregate weigh hoppers of 9000-lb. capacity, and one water batch weigher of 1000-lb. capacity. These, plus an admix batcher, all have separate scale mechanisms. Control of charge and discharge is from a central operator's platform; the operation is by air rams. A second operator at the central panel controls the batching and mixing of concrete. Below the mixers is a two-compartment wet concrete hopper arranged to receive feed from the mixers singly or jointly. Aggregate is delivered to the main plant by belt conveyor and distributed to different compartments by a rotating system. Bulk storage for cement is provided, and the output of pumped concrete is through 6-in. dia. pipes at a maximum rate of 60 cu. yd. an hour.

does not seem to be any manpower shortage. Most firms can get an adequate number of apprentices and some can even exercise a considerable measure of choice. Therefore, recruitment to the middle cadre, the technicians, should also present no problem.

Technical colleges make a numerically greater contribution than the universities and they do so at every level except that of the research scientist. There has been a remarkable development in the volume and standard of work in technical colleges. Post-war needs have accelerated this development and a new pattern for technical education is emerging in England. There is to be a small group of institutions called colleges of advanced technology, at present eight in number. These colleges are to concentrate on advanced work, mainly, but not exclusively, in the form of full-time sandwich courses. Next there is to be a group called regional colleges. These will generally serve a wider area than that of a single education authority. They may offer sandwich courses as well as a large volume of advanced part-time work. Next there are to be area colleges and local colleges: these will be concerned with technical studies at a lower level, and work of a non-vocational character. In the past the development of courses of graduate standard in technical colleges has been handicapped by the lack of an award commanding national recognition like a university degree. The new Diploma in Technology established by the National Council for Technological Awards under the chairmanship of Lord Hives removes this handicap and a rapid expansion in the volume of advanced work in the major technical colleges may be anticipated. The diploma is to be equivalent in standard to a university degree and already there is a demand that the Council establish a higher award comparable with a Ph.D. When that comes about it will be stimulating to see a considerable two-way movement of graduates between the colleges and the universities for postgraduate study and research.

There have been developments, too, in the universities. They have all science and technology in accordance with Government policy and further expansion is being planned in selected centres.

The sub-professional group, comprising the skilled craftsmen, supervisors and technicians, whose education is provided for in part-time courses, will be handled by the appropriate technical colleges: the universities clearly have no interest in this field. In the professional group the research scientists will remain a university product, but the development engineers and designers, and the production engineers and managers, may be educated either in the universities or in the colleges of advanced technology as in some of the regional colleges. The university courses follow a uniform pattern of three years post-intermediate and lead to a degree. In the technical colleges there is some variety. The new sandwich courses leading to the Hives diploma will probably be of 4 or 5 years' duration. Some colleges now offer courses leading to the London external degree and these may be on a full-time or a part-time basis. Lastly, there are the widespread part-time courses leading to a Higher National Certificate. Not all of those obtaining this certificate can be reckoned as of full professional status. Probably about half those getting HNCs' will, with further study and experience, reach full professional status. The major increase in the output of graduates will come from the technical colleges which are linked with the greater stream of part-time education, and it is in this stream that there is an appreciable reserve of good brainpower which could be selected and transferred to full-time courses.

The accommodation, equipment, staffing and conditions of service in the colleges of advanced technology are to be comparable with those in universities and there is to be the same emphasis on research. The courses are to have the same content of basic science, and hence the man graduating after a five-year sandwich course will be pretty much the same type as the three-year university graduate after he has done a two-year postgraduate apprenticeship. There are now two routes to the same goal and a substantially larger number may well elect to take the sandwich course route.

To be efficient the engineering industry must have good management. Good management permits the maximum return to be reaped from technological advance. Management studies therefore should have a place in engineering education. They are commonly undertaken at the postgraduate stage. The ideal arrangement would be a planned series of short residential courses spaced throughout the earlier years of a man's professional life. In the hustle and bustle of industrial life there is little time for reflective thought, and unless opportunities are specifically provided, creative thinking about one's job goes by default.

In the sub-professional groups, supervisors, technicians, and skilled craftsmen there does not appear to be any problem of a shortage. Technicians may be recruited from senior apprentices or skilled craftsmen, or directly from school. Supervisors will generally be promoted from the ranks of the skilled craftsmen. Since a higher standard of technology needs to be backed up with better technicians and craftsmen, the time has come when British industry should make a serious examination of the apprenticeship system. This training is now more thoroughly organized on the Continent than in Britain. Compulsory classroom instruction is given and the apprentice must pass a written, oral, and practical examination before he can be certified. In Britain it is possible for a youth to become certified as a skilled craftsman without having attended a single class or passed a single examination. Serving time is the only compulsory requirement and in many cases served in a rather slipshod fashion.

The technician group does not present any serious educational problems. They can, at the moment, be adequately trained in part-time courses of the City and Guilds type. The upper limit of the technician group is not sharply defined. It merges gradually into the work of the professional engineer, and many technicians can attain professional status through additional part-time study. The standard of their work is rising and before long some kind of sandwich course may be needed to give a more rapid and intensive training.

Co-operation between education and industry is much better than it used to be. Through conferences, discussions and visits, each has now a better understanding of the problems of the other. This is true both for universities and technical colleges, but there is still scope for improvement.

QUICK MEASUREMENT OF MOISTURE AND DENSITY

The use of a new portable field instrument for measuring moisture content or density in many materials is illustrated below. It is claimed that a single operator can get accurate determinations in less than two minutes, using a moisture probe containing a radioactive radium-beryllium source of fast neutrons or a density probe containing a caesium-137 gamma-ray source. The probes are used interchangeably with a radioactivity-counting instrument (a scaler). The probes can measure a spherical volume of material with an average diameter of 14 in. Depth of measurements ranges from the top 12 in. to 60 feet. Accuracy is said to be within 2 lb./cu. ft. for density determinations between 50-150 lb./cu. ft.; for moisture, 3/4/lb./cu. ft. from zero to 100%. (Photo: Nuclear-Chicago Corporation, Chicago, Ill.)

CORROSION OF STEEL REINFORCEMENT IN CONCRETE

C. D. Coppard, *Civil and Structural Engineers Review,* v. 11, No. 9, Sep., '57.

Corrosion of reinforced concrete produces ugly rust stains which disfigure the external walls of many structures and symbolize what might be called the bleeding to death of a structure, the systematic eating away of its core.

The actual stages of corrosion of reinforcements have not been fully appreciated, with the result that this critically serious problem has often been brushed aside. This, despite the fact that the steel provides almost the entire tensile strengh of reinforced concrete and that renovation or maintenance of such steel is often impossible and always expensive after its inclusion in the concrete.

A basic problem in the construction is the establishing and maintaining a powerful bond between steel and concrete. It is therefore common to specify a number of steel reinforcements of comparatively thin rods in preference to a single rod of equivalent weight, because the former offer a greater surface area and therefore greater adhesion. Because of this, however, the corrosion hazard is much increased since even light rusting of thin gauge steel may affect its strength significantly. The problem of adhesion on the one hand and the corrosion hazard on the other has led to a curious anomaly resulting in the practice of specifying steel of increased thickness in order to discount loss through rusting.

Rusting occurs because the steel is given no protective coating. This is due to the belief that applied coatings prevent a lasting adhesion and result in slip, and that rust, inevitably forming on the steel surface, will permanently supply this bond. However, on external walls at least it is impossible to obtain a permanent or even semi-permanent bond between unprotected reinforcements and concrete.

Weathering

Weathering of the steel, in the contractors yard is commonly used to remove the layers of millscale formed on the steel surface by various hot rolling and shaping processes at the steel mill. In most other industries the weathering process has fallen into disrepute for the following reasons. Millscale is rarely formed as a continuous layer and is characterized by a multitude of microscopic fissures which allow corrosive media to penetrate to the underlying steel. Because the scale is a spent oxide it is cathodic to the steel and will help to promote attack on exposed areas of metal. Weathering provides ideal conditions for this to occur, the scale is detached by rust forming between the steel and the scale layers, and severe corrosion and pitting occur.

This rust which is an oxide comprises part Fe_3O_4 and part non-reducible Fe_2O_3. The concrete immediately adjacent to the steel is unlikely to become completely dehydrated for some considerable time, particularly if the concrete is thick. During its period of setting and maturing, the concrete exudes free limes and other corrosive alkalies which, distributed by the moisture set up a pickling action on the steel. This causes the dissolution of the Fe_3O_4 and the cleaning (often to the point of brightness) of the substrate. In the course of this reaction the indissoluble Fe_2O_3 becomes integrated with the maturing concrete and makes a good bond.

In achieving this bond however, the relationship between steel and concrete is established in a very delicate state of equilibrium. Pickling produces a "rawness" of the substrate by laying bare the grain structure of the steel in a manner similar to shot blasting. Moreover, the possibility of maintaining this state of equilibrium is a purely academic concept, impossible in practice on external walls of most concrete structures. Given the presence of an electrolyte — even small quantities of water are sufficient — and the whole balance is upset; violent corrosion is almost inevitable simply because pickling has opened up the very fabric of the steel. Unless the concrete is dehydrated rapidly the uncontrolled pickling action can cause quite serious metal loss.

When the concrete has dried out it becomes more or less porous, and the reinforcement is therefore liable to attack from any water-borne corrosive media which may filter through the concrete from the air or water of the environment, in spite of the presence of waterproofing applied to external walls of the structure. Sulphur compounds in industrial atmospheres frequently adhere to external walls and become absorbed by rain water, enter the concrete and attack the steel as sulphurous acid.

Rust occupies a space five times that of the steel it replaces. In effect, therefore, the steel expands and since the concrete cannot accommodate this expansion, and because the growth of rust cannot now be stifled, the concrete is forced away from the surface of the steel by an ever-growing parting layer of rust. This is the primary cause of spalling which consists of fissures in the concrete caused by its movement away from the reinforcement, and each fissure provides ready access to further corrosive agents.

Remedies

Various remedies have been proposed such as regulating the different proportions of constituents in the actual concrete. Use of a slag aggregate has been suggested but this is not satisfactory due to the danger from sulphur compounds found in slag and cinder. Employing an increase in the ratio of cement to aggregate increases the density of the concrete and improves the barrier to entry of corrosive agents. However, the concrete will eventually tend to leach out and become porous. Waterproofing compounds applied to concrete can undoubtedly help. They require frequent renewal and can cause a serious problem if there is a poor bond between the coating and the concrete. In this state corrosive agents can penetrate the coating, seep through and attack the steel without making themselves evident for some time. That is, waterproofing compounds may tend to conceal corrosion of the reinforcement.

Coating Protection

It is suggested that one effective method of protection is by coating the reinforcing steel with a resistant film, developed over the last seven years by a British company. This procedure is described as taking place in three stages. First, the application of a chemical descaling jelly or solution which is capable of removing mill-scale in a few hours. The process is non-corrosive and does not attack the underlying steel as does weathering. The chemical can be applied by dipping, spraying or brushing. Second, a process is used which simultaneously removes rust and deposits a phosphate coating on the steel surface and in the actual grain structure of the metal. The coating is amorphous, inert, water-insoluble and has a high electrical resistance. It provides a strong bond between the metal and subsequently applied coatings, increasing their resistance to impact, abrasion and corrosive media in the environment. Again, it can be applied by immersion, spraying or brushing. The third stage is the application of a chemical sealer, applied by similar methods, which combines with residual solution from the previous process to form a strongly rust-resistant barrier.

This coating is unaffected by moisture after a drying time of 30 minutes and will withstand storage of the steel under hostile conditions prior to inclusion in the concrete. It is impervious to acid and alkaline attack, and will not saponify or decompose under attack from lime or other alkalis exuded by the concrete during the drying stage. Also, the sealer offers a strong bond between metal and concrete and the high electrical resistance of the phosphate coating stifles the electrolytic mechanism of the corrosion action and prevents rust creep if, for any reason, the sealer coating suffers localized penetration.

DISCUSSION

The Editor invites discussion of technical papers and other articles in *The Engineering Journal.*

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

The CF-105 Avro Arrow

The CF-105 Avro *Arrrow* delta-winged fighter, Canada's first supersonic aircraft was seen publicly on October 4. The twin-engine, long range interceptor was first rolled out of Avro Aircraft Limited, Malton, Ont., that day climaxing a program of engineering research and manufacturing techniques in fields completely unknown when the project was undertaken.

It was four years from the date when the "go ahead" for the design and manufacture of a successor for the CF-100 was given by the government.

A big, versatile aircraft designed to operate with a crew of two, from existing runways, the loaded weight of the *Arrow* is of the order of 30 tons; its speed, 1000 miles plus.

Primary armament of the aircraft are the aair-to-air guided missiles installed in a detachable armament bay in the fuselage. Versatility provided by this bay will enable the aircraft to perform other roles. The *Arrow* will be equipped with one of the most advanced integrated electronics systems, which will combine the navigation and the operation of the aircraft with its fire control system.

The *Arrow* was designed for the R.C.A.F. as a defence factor. It is considered one of the most advanced combat aircraft in the world, produced from very complete tooling which will allow production to follow development without undue delay.

The first *Arrow* and the next few developmental aircraft will be equipped by Pratt Whitney J.75 engines. Ultimately however, the new Orenda *Iroquois* will power all production aircraft.

Wind tunnel tests were being run within two months of authorization. Seventeen models of various sizes were used to obtain necessary structural and aerodynamic data. Wind tunnel limitations caused Avro engineers to explore further techniques for obtaining important aerodynamic data.

Eleven large scale free-flight models with rocket-propelled boosters were fired at ranges in Canada and the U.S. between 1954 and January 1957. These models were instrumented and transmitted their inflight information back to a ground station.

Aerodynamically, the *Arrow* was entering a new realm of science. Analog computing equipment was installed to accelerate the solution of aerodynamic and stress problems. The company also obtained a new electronic digital computer to accommodate its accelerated research development program in supersonic aircraft. This was the IBM 704, a giant computer.

At 1200 m.p.h., air friction raises the temperature of an aircraft's skin by 300 degrees F. At high altitudes with the outside air temperature at 50 degrees F. below zero, the skin temperature is still 40 degrees F. above boiling point of water. Also at this speed, at high altitudes, the perspex canopy enclosing the pilot and radar-navigator would start to blow out like bubble-gum, due to high friction, plus the fact that the inside of the canopy is pressurized. This was overcome by installing tempered glass windshields about an inch thick.

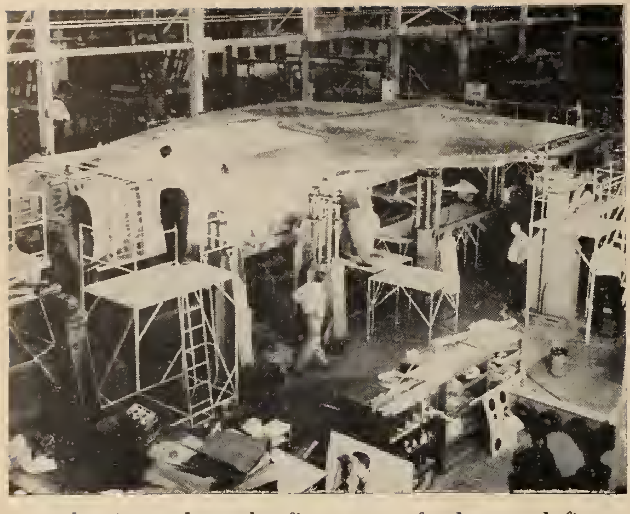
Two main types of detrimental sound, jet engine and aerodynamic, can cause skin panels to fracture and rivets to loosen, again weakening structures. Sonic structural tests are being carried out constantly and will continue until they have run long enough to indicate satisfactory panel life.

The air-conditioning system in the *Arrow* must be capable of handling temperature changes of 100 degrees F. a minute.

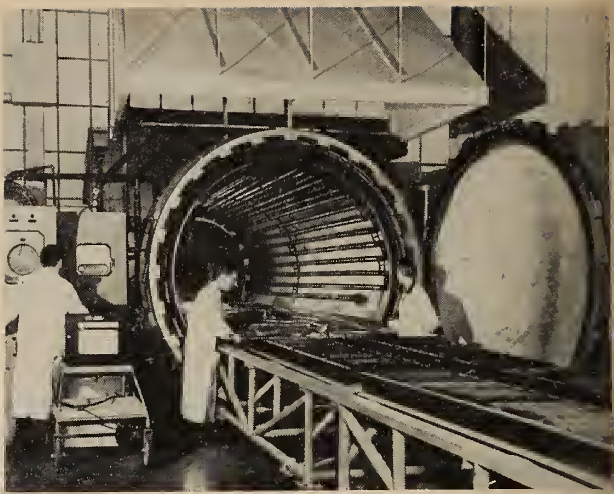
New machines including a 15,000 ton rubber pad forming press, a big metal-to-metal bonding autoclave, a special heat treat furnace, a giant skin mill and heavy machining equipment were brought in by Avro. Six hundred and fifty suppliers in Canada have been engaged in the manufacturing of parts.

Fabricated and assembled in less than two and a half years from the date of the first design release the

The CF-100 Avro *Arrow*.



In the Avro plant, the first centre fuselage and first inner wing in assembled position.



Metal to metal bonding. This big autoclave bonds together metals coated with a special adhesive.

first *Arrow's* man-hours-per-pound ratio is approximately 80 per cent of projects of similar size and complexity in North America.

Now exposed to exhaustive testing, and the installation of extensive, specialized instrumentation, the flight date of the aircraft will depend on problems to be dealt with during this phase of the program.

Avro hoped that the first flight would be made before the end of the year.

That the new aircraft will be a real contribution to the defence of North America was the tenor of the remarks made by military and government people at the October 4 ceremonies. The theory that missile development would soon make manned interceptors obselete was said to be unlikely. Rather, it was estimated, these technically advanced manned aircraft will be a necessary requirement of the arsenal of the West for many years to come.

Some Features of the CF-105

Delta Planform: gives thin, high wing section — advantageous for supersonic flight — and sufficient physical depth in wing root section to house undercarriage plus large amount of fuel. Delta also gives efficient and relatively light structure and good general control at transonic speeds.

Twin Engine: gives twice the thrust without double fuselage area, and gives increased reliability.

Materials: It is an all-metal aircraft. Metals are used which had not reached the research stage when design of the aircraft began. Metal to metal bonding of magnesium alloys was developed for this plane by Avro.

Manoeuverability: Plan was for utmost reliability in severe high temperature, high altitude environment.

Heat and Sound Problems: The Arrow is on the threshold of the Heat Barrier. Studies are underway to adapt it to even higher speeds.

Ground Handling includes a jeep-mounted gas turbine as an engine starter, and a power-and-air conditioning truck which can maintain a constant airflow at 55 degrees F. to the weapon, electronic and other sensitive equipment, and some 200 pieces of equipment.

Control Mechanisms: Provide sufficient power to counteract extremely high air loads on control surfaces.

Electronic System: R.C.A. developed a new electronic system for automatic flight, weapon fire control, communication and navigation, which has been designated the Astra I system.

Testing proved basic soundness of the structural and system concepts prior to building. Test of fuel system, eg., caused a simulated test system to be subjected to simulated flight sequences and emergency operation of pressure, refuelling and de-fueling systems. Stress tests using plastic models confirmed that results of analytical structural studies had beeen valid.

Quality Control: 38,000 parts were checked by quality control and inspection department, with smooth flow to shops. Interchangability of parts and components was studied. Innovations on inspection speeded production.

Methods: Difficult machining and forming operations were undertaken and solved. Milling of wing skins and large machined parts provided tremendous integral increase in structural strength. Bonding method devised is stronger and lighter.

The B.C. Interior

Years of speculation in British Columbia on the future of the northland have been brought to a head by surveys indicating a four million horsepower hydro development is feasible.

Axel Wenner-Gren, Swedish financier, responsible for the surveys, and for a dream now cherished province-wide, foresees a billion-dollar industrial empire. With an estimated cost of up to $600 million, more than the St. Lawrence Seaway, power output could begin by 1964 turning out at full production, four times the power generated by Boulder dam. While these speculations are the results of a purely interim report, the provincial government has signed agreements for further surveying of dam sites.

The energy would be generated in the Rocky Mountain "trench", a huge geological fault 10 to 20 miles wide running from the U.S., northwest to the Yukon.

Wenner-Gren is spending $5 million surveying a 40,000 square-mile area along this fault, some 400 miles from the north of Prince George to Lower Post, on the Yukon border. He hopes to run a revolutionary monorail railway all this length, in return receiving priority in mining, lumbering and power development concessions.

Later this year a Toronto firm expects to make an interim report on its aerial survey with magnetometers of the mineral content.

Reports suggest improved navigation on the Mackenzie River; channelling of the Peace River so that neighboring Alberta will benefit; provision of Vancouver and southern B.C. with cheap power so that the salmon fishery on the Fraser River need not be destroyed. *(Abstracted from Montreal Star, October 16.)*

St. Lawrence Seaway and Power Project

Though weather continued favourable for all aspects of construction during September, the peak employment of some 21,000 attained in August was not exceeded, due to completion in early September of certain features such as concrete on the Iroquois dam and the two American locks. River improvement in the International section, under way by both power authorities, was generally on schedule. Dry excavation was on schedule. Dredging was slightly behind schedule, particularly on the south channel, but this will not affect opening of navigation for 14-foot draught vessels by July 1958. Clearing of park areas was 62 per cent completed by end of September and will continue throughout winter.

Progress by Ontario Hydro

By end of September some 770,000 cubic yards of concrete or 74 per cent had been placed in the Canadian half of the international power-house. It was estimated 90 per cent would be placed by year-end and placing will continue through winter months. Placing of concrete was completed on all draught tubes and three intake sections were completed to full height.

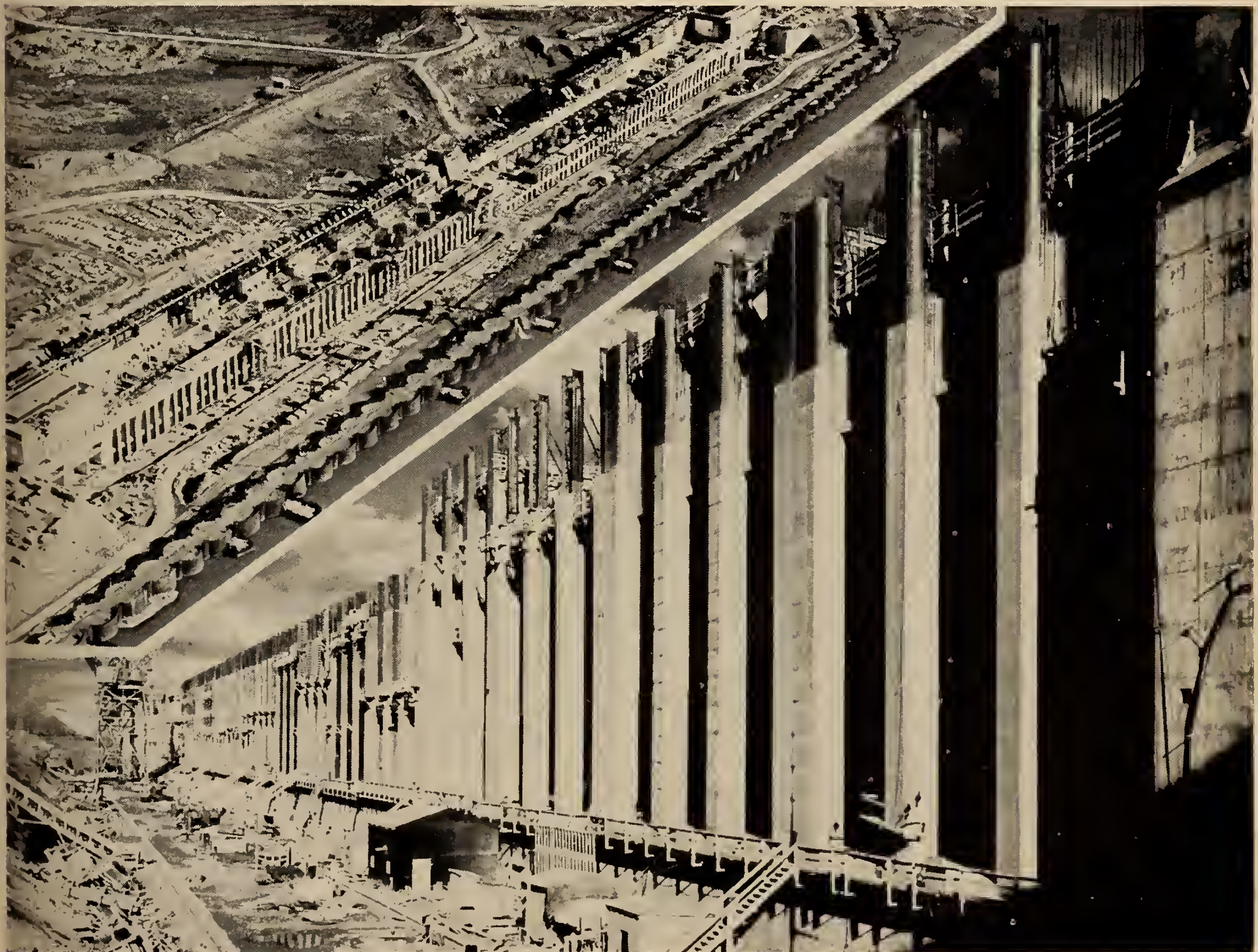
Twelve turbine speedrings had been set and one runner was delivered. Runner installation was scheduled for end of October. Installation of the headgate gantry was completed and tested. Generator equipment deliveries were commencing. Taintor gates for the ice sluice were being installed. More than half the headgates were delivered but installation had not started. Dikes will be completed by end of October excepting for riprap, with final completion scheduled for year-end.

Progress by NYSPA

At month-end some 820,000 cubic yards of concrete, or 75 per cent, had been placed in the American half of the international power-house. concrete for all draught-tubes had been completed and concrete in three intake sections had reached full height. By year-end 90 per cent of completion will be attained as scheduled. Work on all dikes was to be completed excepting for riprap by end of October.

Drum gates for ice sluices were being installed. Installation of the

Two views of the St. Lawrence power dam. There are 96 intake openings.



large gantry was almost complete. Nine turbine speedrings had been set but no runners were in place. Deliveries were commencing on headgates for the American half, as well as on the generator equipment, as scheduled.

The contractors on the Long Sault dam had caught up with their schedule, with some 500,000 cubic yards or 81 per cent of the total concrete placed at end of September. Concrete for the second stage will be completed by Christmas. The third stage involves the filling in between piers on the first stage or half. River flow will be diverted back to the north channel in March. Gates in stage 1 are being used temporarily for closure in upstream gains. Ultimately, 18 will be operated in final position by gantry cranes and 12 will be operated in final position by gantry cranes and 12 will be operated by fixed hoists.

All concrete had been placed in Iroquois dam by mid-September and cofferdam had been breeched. Only final removal of cofferdams, installation of gates and gantrys and cleanup remained. Final completion is expected in December. Ontario Hydro was to take over operation of the dam early in October and water level in the pool upstream was to be raised some 6 feet by mid-October to present Lake Ontario level at Ogdensburg.

At the Massena intake some 200,000 cubic yards of concrete had been placed by month-end and gates were installed. All construction here will be completed by the end of November and cleanup will be finished by the end of February.

Progress by SLSDC

All concrete had been placed in both the Eisenhower and Grasse River locks, and installation of lock gates and machinery was under way by the end of September. Both locks will be fully completed for the opening of 14 foot navigation next July. Only a million cubic yards of excavation remained to complete the Long Sault canal, with final completion expected by year-end.

Progress by SLSA

Activity continued on all aspects throughout September with employment equaling or exceeding that of August. At the Iroquois lock the second stage cofferdam was flooded early in the month, and clearing of the channel for navigation continued. The rolling lift bridge was in operation, sump pumps, gate operation machinery and electrical equipment were being installed and standby diesel generators were delivered.

At Beauharnois lower lock, 68,000 yards of rock were removed in September, and 36,000 yards of concrete were placed, bringing total to 160,000 yards placed to date. Two thirds of the chamber walls were complete to full height and the approach walls were started both up and downstream. At the upper lock 520,000 yards of earth and a million yards of rock had been excavated to month-end and 90,000 cubic yards of concrete placed at the upper and lower ends where gates and machinery will be installed.

Long Sault dam. This view shows, left to right, the Stage 1 structure, the Stage 2 spillway section and the north bulkhead.

The lock structure at Cote Ste. Catherine was nearly all poured to full height and the floor completed. 83,000 yards of earth and 213,000 yards of rock were moved during September, while 38,000 yards of concrete were poured, bringing total to 285,000 yards. No installation of gates or machinery had been commenced. At the St. Lambert lock 98 per cent of the concrete had been placed and installation of taintor gates, valves, etc., was about to commence.

Elsewhere, the suction-dredging contract at Welland lock No. 1 was completed during the month, while most of the other channel excavation and dredging continued at or close to schedule.

On the bridges in the Lachine section, the new Jacques Cartier through-span was erected including walkway, and downstream trestle to support the existing deck span when it is removed was being erected. All of the piers at south end of the Honore Mercier bridge were completed. On the C.P.R. Caughnawaga rail-bridge, piers for the new lift-span were poured to full height and lifting and ballasting of the railway south of the bridge were under way. At Victoria bridge a derrick and erection equipment was being set up, while a building platform for erection of the lift-span had been placed. Timber cribs for a road underpass and a retaining wall along the dike were built and some of the fill placed.

On the substructure for the new international high-level highway bridge over the St. Lawrence river near Cornwall, to replace the Roosevelt rail-highway bridge, approach trestles at both ends were completed and work on the main river piers was proceeding, with completion of substructure scheduled for February. The old bridge has to be removed by July 1, 1958. Removal will commence after the ice goes out in the spring and traffic will be carried by a ferry until completion of the superstructure by SLSDC.

Seaway News

Limitation to size of ships through seaway locks to 25½ ft. draught, recently announced, is bringing about new designs by naval architects for new types of 'ocean-seaway' type vessels, able to operate both 'inside' and 'outside'. These new dual purpose carriers will be radically different from anything seen on the Great Lakes up to the present.

Highlights of this new type of vessels are:

—variable pitch propellers to permit manoeuvering on the propeller rather than on the engine, — navigating bridge aft for easier cargo handling, —accomodation for ocean-going fuel and water supplies, not needed in 'lakers' with their ready access to fuel and fresh water, — integrated package-freight handling, with palletized fork-truck operation replacing traditional mast and boom handling, package freight carried on between deck and tank top, autos on top deck. — interior cargo space free of stanchions. Long deck hatch allows carrying steel girders of maximum size. Ocean-type deck hatches equipped to add mast and boom for all ocean runs in winter months.

Naval architects see more to be gained from improved cargo-handling than from atomic power. Cargo handling costs make up a third of a general cargo ship's operating expense, with fuel costs only amounting to about 12 per cent.

It is generally agreed 80 per cent of the expected total seaway trade will be in ore, grain, oil and coal. This is the type of cargo that the 'lakers' always handle most economically. But general cargo, — what importer, exporters and ocean shipping lines look for, — will amount to between 6 and 11 million tons yearly. This is the trade the new type ocean-seaway vessels will compete for. Another advantage claimed for them is adaptability for ocean traffic during the winter freeze-over on the seaway. They may also bid for the Labrador ore run to upper lake ports because winter earnings will make up for smaller cargo capacity through seaway locks in summer.

Water Diversion Delayed

The attempt to divert an extra 1000 cubic feet per second out of Lake Michigan into the Illinois waterway has been abandoned for 1957. An effort was made to push through the proposal without hearings before the Senate Public Works Committee but this was beaten down. Now, hearings will resume in congress early in the next session in January.

The 'Chicago Water Steal', so labelled by Wisconsin Senator Alexander Wiley, was twice approved by congress, and each time President Eisenhower vetoed it because of Canadian objections. But because Lake Michigan is entirely in U.S. territory supporters view the diversion as strictly an internal U.S. affair. Illinois congressmen, gathering heavy support will make a determined effort to push the measure through.

Dispute Over Filtration Plant Costs

City officials of Cornwall Ontario are trying to get Ontario Hydro to pay part of the cost of the city's $2.2 million water filtration system. They point out that the New York Power Authority has agreed to pay between $400,000 and $600,000 towards the cost of a new sewerage plant being built by the town of Massena, N.Y. They claim it is unfair for Canadian money to be spent towards the sewerage plant while none is available for the Cornwall filtration plant. The power phase of the seaway project is split 50/50 between Ontario Hydro and NYSPA. Ontario Hydro claims turbidity of the water for Cornwall will not be increased, nor will pollution be such as to require filtration treatment.

Prairies Ask For Port Survey

Manitoba claims the three prairie provinces are agreed that Ottawa should launch an immediate survey of port requirements at Ontario's Lakehead. Manitoba's minister of industry and commerce, F. L. Jobin, says Western Canada will use the Lake Superior port of Duluth, Minn., instead of the Lakehead if the latter's facilities are not made adequate. He warned in September that Manitoba, Saskatchewan and Alberta intend to make a joint request that Ottawa should accept its responsibility in developing the Lakehead, and hire a consulting firm to make a full study of requirements.

New Plant Sites Opposite Detroit

An 1800 acre industrial site on the Canadian shore of the Detroit river is being developed at Ojibway, midway between the Montreal and Chicago terminals of the seaway. It has a mile-long frontage. Included in the property are warehouses, a wire mill and, a deep water slip with wharf and double tracks capable of berthing seven ships. Since its sale to a group of Chicago businessmen early in September the purchases have added 400 additional acres to the site. The original 1400 acres were purchased at a price of $10½ million.

Here, bonded warehouses will provide for overnight delivery in the general Chicago area and points further south and east. Shipments could be transhipped by rail and arrive in Chicago in eight hours via the N.Y.C. rail tunnel. Facilities of the C. and O. could be used in much the same way to points such as Milwaukee.

U.S. Toll Conferences

At the first open conference on means of establishing and collecting tolls, held in Washington, September 9, SLSDC Administrator Castle publicly rejected proposals for a toll-free seaway. Representatives of ship lines and shipping interests endorsed tolls to assure the seaway would be self-supporting and repay its cost in 50 years. A majority opinion appeared to favour tolls based on size of vessels and weight of cargo.

Mr. Castle said the estimated $2 million for annual operation and maintenance appeared more than ample to cover all out of pocket expenses for the U.S. portion of the seaway. Lyndon Spencer, representing the Lake Carriers Association, voiced opposition to tolls. His group realized that tolls were necessary to obtain participation by the U.S. in the opening of the Great Lakes to commerce of the world. However, bulk cargoes and bulk cargo vessels in ballast, he maintained, should be as nearly toll-free as possible.

At hearings before the SLSDC Toll Committee at Chicago on September 11, M. M. Cohen, general manager of the Chicago Regional Port District, held it would be difficult if not impossible to liquidate the investment through tolls collected in a period of 50 years.

Several speakers expressed the view that the Welland canal was not part of the seaway and that it should remain free. Canada, they observed, had gone on record that the Welland will be tolled to recoup the cost of improvements done in connection with the seaway. On the other hand, the U.S. corps of Engineers was spending more than $100 million to improve the Great Lakes channels and this is not to be paid off through tolls.

Canadian Toll Conference

At the one day public hearing on the tolls question at Montreal on September 19, sponsored by Canada's Seaway Authority, no-toll supporters described tolls as 'foreign to Canadian tradition', and 'not in the national interest'. The Dominion Marine Association declined to discuss a tolls formula. They disclosed a brief submitted privately to the Minister of Transport, forecasting initial traffic of 20 million cargo tons in 1959, increasing in the following ten years to 3 million tons. This DMA estimate is far below previous unofficial figures of 36 million tons the first year.

Some briefs submitted flatly advocated a no-toll seaway but added that if free passage was impossible the toll structure should be the lowest possible. Only the Railway Association of Canada brief, representing 22 railroads, asked for an 'equitable' toll high enough to amortize costs and operation over 50 years.

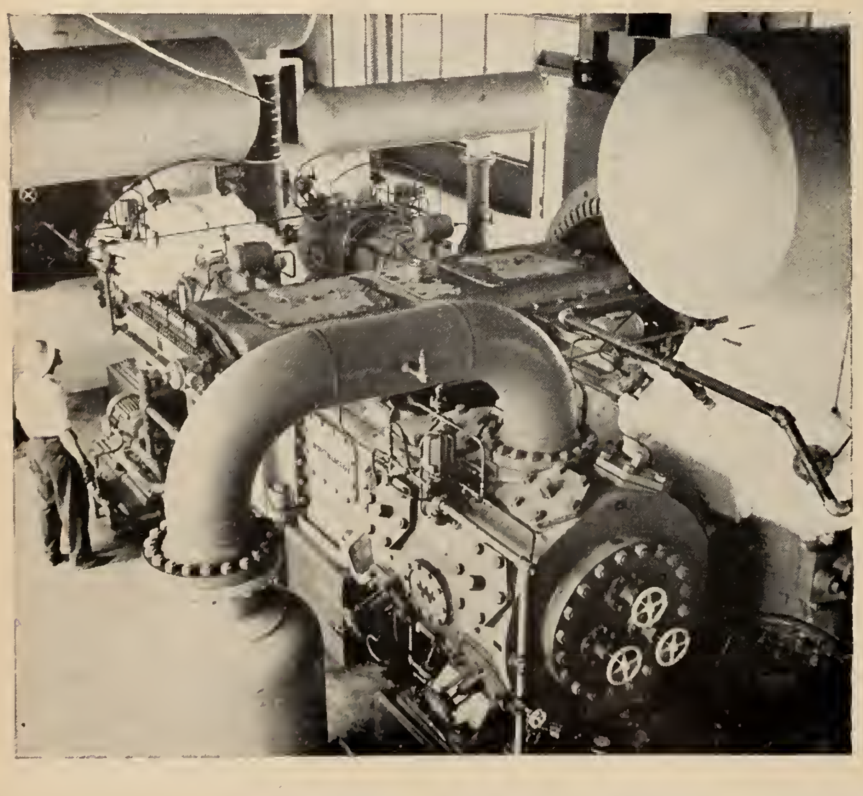
The Canadian tolls committee is working on a dual system, — a low rate on ship tonnage and a higher rate on actual cargo tonnage carried. Canada Steamship Lines said the composite structure was sound if tolls must be imposed. But to protect domestic shippers it wanted a higher toll for general cargo to or from foreign ports.

Canadian Pipeline Projects

At end of September, with Westcoast Transmission's construction completed and filled with Canadian gas, about 95 per cent of the distribution system of Inland Natural Gas was completed in market areas and construction of 24 city gate services was nearing completion. Natural gas had reached Savona and was being used to clean the system.

British Columbia Electric Company expects to be delivering Canadian gas by year end, not only to the entire Vancouver area but will also be serving Burnaby, North Vancouver and New Westminster.

Carbide Chemicals. These refrigerant-compressors form part of the Carbide Chemicals Company low temperature equipment, at Montreal East. A multi-million dollar polyethylene and petrochemicals plant was added to the Montreal East operations of the company recently. The highly specialized equipment at the plant is used to convert petroleum refinery gas concentrates into ethylene oxide, ethylene glycol, other ethylene oxide derivatives, and polyethylene. The chemical reactions are carried on in tanks, towers and 436 miles of pipes. Raw materials are supplied by three of the neighbouring refineries. The complex production processes require extremes of heat and cold and tremendous pressures.



Trans-Canada Pipelines

With the 34-inch western section completed as far as Winnipeg and filled with Alberta gas, attention was focussed on the race to reach Lakehead with the Crown Pipeline before winter. Work was proceeding at a crawl on the triple channel crossing over the Winnipeg river near Kenora, Ontario, one of the toughest river crossing jobs in Canadian history. Here three drilling barges were in operation, with right of way being cleared and graded for twin pipelines. Between Winnipeg and the Ontario border, completion was expected by mid-October. Further east, confidence was expressed that the Toronto - Montreal 310 - mile section would be laid and testing completed before year-end.

In spite of an explosion on the Trans Canada pipe two miles west of Babot, Manitoba, which left a crater 100 feet wide, 240 ft. long, and 20 ft. deep, repairs were completed rapidly and natural gas was turned on at Regina the following day, making it the first city to receive gas via the Trans Canada Pipeline.

Winnipeg and Central Gas

Company has 250 miles of mains ready to receive Alberta gas, expects 4000 residential customers by year end, to add to the 15,000 it now has.

The Public Utility Board has set rates, lower than those asked by the Company but higher than the City contended they should be. Estimated cost of heating an average home, — $199; average cost per 1,000 cu. ft. — $1.03. Competition at lower rates from Great Northern Gas Utilities at Brandon, and Great Plains Gas Co. are ruled out by Trans Canada, which considers itself bound by contract to serve gas exclusively to Winnipeg and Central Gas Company.

Northern Ontario Natural Gas and Twin City Gas

These associated companies expect to serve 34 communities between Kenora and Orillia, six of which will be served by Twin City. Construction is proceeding on the Kenora lateral. Work on all 34 systems will be underway next spring. Biggest jobs will be the Trans Canada 82-mile lateral to Timmins. All engineering will be done this fall and winter so contracts can be let early in 1958.

Union Gas Company

With deliveries of 26-inch pipe commenced in the last week of September, welding and laying of pipe was under way on its 142-mile line to Hamilton at month end. Distribution systems were under construction at Stratford, Guelph, Strathroy, while franchises were being awaited at Kitchener, Waterloo, and St. Marys. United Fuel Investments was starting to convert parts of Hamilton to natural gas in mid-September. Some of the city will not be converted until early 1958.

Consumers Gas Co., Toronto now distributes imported natural gas to areas from Brampton and Streetsville on the west, to Bowmanville on the east, and north to Newmarket. It has a franchise to serve Bradford and six major communities along the Georgian Bay to Owen Sound. Through Provincial Gas, its subsidiary, it serves Fort Erie and Niagara districts and has acquired control of Inter-provincial Gas at Ottawa and Hull. It has a franchise for Brockville and is competing for service to Kingston and points along the Ottawa Valley. Company now plans a $750,000 distribution line to Lindsay.

Additions this year include 28 miles of 12-inch main and 63 miles of 10-inch, 8-inch, 6-inch, and 4-inch mains at a cost of some $4.3 million. The grid or feeder program has been completed and is now being filled in with distribution lines.

Lakeland Natural Gas: Company has 775,000 feet of pipe on hand for city and town distribution systems. Contract awards are pending in 19 municipalities where certificates are received from the Ontario Fuel Board in the area between Port Hope and Cornwall. It is expected a large proportion of the pipe will be laid this year. Large pipe comes from Page Hersey Tubes Ltd. One hundred and forty-three thousand feet of ¾-inch service pipe has been purchased in Scotland. Work will probably be started at Port Hope, Trenton, Coburg, Belleville and Cornwall.

Quebec Natural Gas: With some 10 miles of the 34 miles of 24-inch to 16-inch main completed across the island of Montreal by late September, work on this was expected to be completed by mid-November. Laying of the distribution system was proceeding on the eastern half of the city. Some 400 men were at work on conversion surveys of customers' requirements in 40 conversion districts. If the Trans Canada line from Toronto is completed by January to link up at the west end of Montreal island, an interim gas supply will be available from the Sarnia area of Union Gas Company. But Montreal customers will not then receive natural gas until conversions of present appliances are completed in the spring.

Tennessee Gas: It was reported late in September that a substantial portion of its holdings of Trans Canada shares had been sold by Tennessee Gas Transmission Co., most of it to a Canadian Oil Company. The amount sold represented close to a third of Tennessee's holdings. It is hinted another one-third of Tennessee's holdings are offered for sale with the same oil company as likely purchaser. These sales, if completed, would substantially boost Canadian participation in the project, possibly effecting a majority of ownership in Canada.

Pipeline News

Alberta and Southern: J. K. Horton, Alberta and Southern Gas Company president, predicted in September that total expenditures in Canada over the next five years would total nearly half a billion dollars on the Alberta-California pipeline. Construction would cost $142 million and operating expenses over the initial five year span would amount to $107 million. In addition, purchases of Canadian gas would exceed $100 million, exploration and development by producers would cost $100 million, and $75 million would be invested in gas processing plants.

Annual payments in excess of $20 million would flow from the U.S. into Canada in payment for gas. The proposed line would have initial daily delivery of 450 million cubic feet, and would run from Alberta to the San Francisco Bay area, he said. If necessary clearances were obtained from Edmonton, Ottawa, and the FPC, construction could be started in 1958, with a completion scheduled for late 1960.

Alberta and Southern will pay some $100 million to Shell Oil Co. over the first 10 years of operation for 200 MM c.f.d. of gas from Waterton-Sarcee, Crossfield and Holmglen Rimbey fields. All the gas from these fields plus all gas discovered over next 10 years in Southern Alberta up to a total of 5 trillion cubic feet will be purchased.

Appliance Sales Booming

Counting in equipment for use with propane, some 25,000 gas stoves, water heaters and other gas appliances were sold in Saskatchewan in 1956, and indications point to a higher sales total in 1957. Saskatchewan Power Corporation has now natural gas for heating Regina homes, and plans to extend the service to Melfort, Tisdale, Yorkton, Melville, Estevan, and Weyburn. Extensions are also nearing completion in Wilkie, Kerrobert, Chaplin and Maple Creek.

Emphasis on Gas Exploration

Wildcatters in Alberta are looking primarily for natural gas reserves today, with oil discoveries ranking as second finds of limited economic value, — a situation unheard of up to even a year ago. Large pipeline companies are hard pressed to find enough gas to meet potential demands. Westcoast Transmission will need 600 million cubic feet daily from the Peace River. Trans Canada will need a billion feet daily within a few years, while the Alberta and Southern project will need 450 million cubic feet daily to start with.

TRAFFIC across the Jacques Cartier bridge at Montreal returned to normal at 10.30 Sunday morning, October 20, after a five-hour shutdown to permit engineers and workers to roll away the 250-foot deck span that crosses the seaway channel on to a dismantling trestle, and to roll a new through span from the erection trestle upstream, into its place on the bridge, a distance of 78 feet.

Both new and old spans were mounted on roller trucks, each resting on runways of seven rails. The spans were coupled and two hydraulic jacks, with pressure of 3,000 pounds per square inch, provided the power to move the spans sideways on the runways. Total weight of the two spans was 3,100 tons. Engineers described the shift as "a world's first in structural steel moving technique". Hon. George Hees,

"Translation" of Span, Jacques Cartier Bridge

Dominion Bridge Company replaced a deck span with a through span over the channel of the St. Lawrence seaway, interrupting traffic over the Jacques Cartier bridge for only five hours on October 20.

Photos by Hans van der Aa

federal Minister of Transport, and Charles Gavsie, SLSA president, watched the operation. Mr. Hees described it as "a Canadian engineering masterpiece".

Dominion Bridge Company engineers have been working on the $7 million project for over a year. The 14 bridge spans affected have already been raised a few inches at a time by varying amounts from zero, to a total of 10 feet at the channel crossing, and have another 40 feet to go between now and the end of 1958. The new span has five traffic lanes, an indication the rest of the bridge will be increased to five lanes in the future. The old span will be dismantled. When the work is completed there will be a 180-foot clearance for vessels using the new seaway channel.

What Goes On

Building Design

A table of computed maximum snow loads and wind gust speeds has been furnished by the Climatological Section of the Division of Building Research, National Research Council, and is available from the Canadian Institute of Timber Construction, Ottawa 4, Ont. In the absence of any building code or by-law, or regulation of authority having jurisdiction, these climatological data may be considered an authoritative basis for design.

Correction

The *Journal* is advised that incorrect information was published on Page 1009 of the July 1957 issue about the chimney of the St. Lawrence Cement Company plant at Clarkson, Ont.

The informed correspondent reports that no traps or filters are contained in this chimney, nor in any other cement plant stack known to him. The installation which the writer had in mind, evidently, is an electrostatic filter (recuperating somewhat over 99% of the dust in the gases) preceding exhaust fan and chimney.

The cost of such a single electrostatic precipitator, the correspondent further reports, including the multiclone, is about one-third of the sum mentioned.

Public Works Contracts

Contracts involving expenditures totalling $5¼ million were awarded by the Federal Department of Public Works during the month of September.

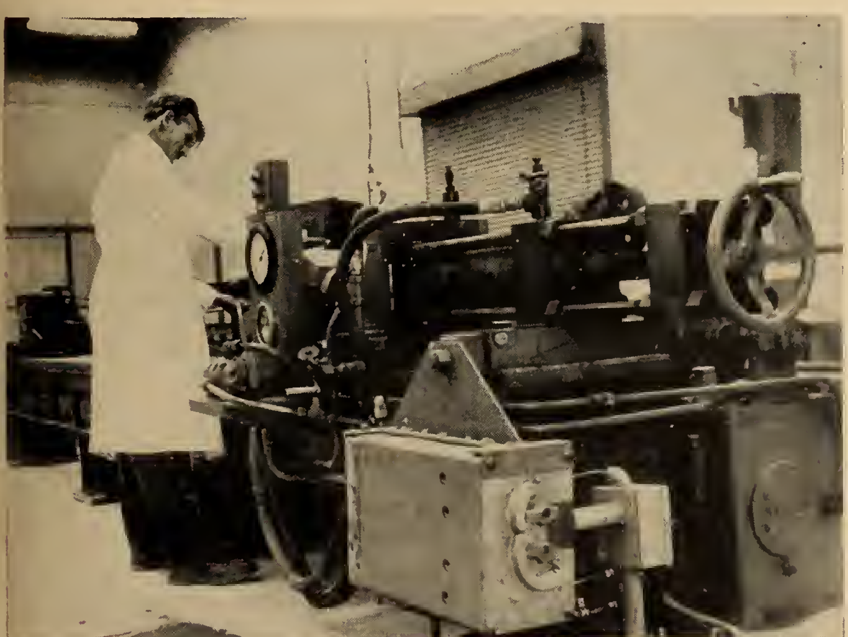
Largest items listed are the Terra Nova National Park, Nfld., Trans Canada Highway, grading, culverts, and traffic gravel, and construction of access road for approximately eleven miles, Concrete Products (Newfoundland) Ltd., St. John's Nfld., $1,635,250.; and construction of a new federal building for the Department of National Revenue (Taxation Division), Bird Construction Co. Ltd., Winnipeg, Man., $1,010,605.

Deas Island Tunnel

The "W. G. Mackenzie", a dredge with a capacity of 2,000 yards per hour, was to go into service on the Deas Island tunnel in November.

The hull was completely built by Yarrow Shipyards, Victoria. After installation of power machinery and equipment it was brought to Vancouver. It is owned by Marwell Equipment Ltd., and operated by B.C. Bridge and Dredging Co. Ltd., a subsidiary company.

Nuclear Plant. The new plant of AMF Atomics (Canada) Limited was opened in September at Port Hope, Ont. This is Canada's first privately owned and operated nuclear plant and laboratory. The primary objectives are: to manufacture fuel elements for NRX and NRU reactors at Chalk River and elsewhere, to design and develop new types of fuel rods, and to conduct research, development and production on research and power reactors. Rough rolled natural uranium is fabricated into fuel elements by heat treating, stretching, straightening and machining as illustrated. There will be by spring, 1958 the equipment to sheath the elements in aluminum cladding.



Nickel Supply

After years of scarcity and priority ratings, nickel should soon be in ample supply and readily available to industry throughout the free world, K. H. J. Clarke, of International Nickel Company of Canada, said recently.

That a smaller proportion of nickel production will be required for stock - piling is an encouraging thing for that reason, in Mr. Clarke's view. His company still plans to increase production to 385 million pounds by 1961.

Edmonton Cement Plant

The many large deposits of marl that exist in Alberta and Saskatchewan will be used in the manufacture of cement.

It is proposed by Imperial Cement Limited to build a cement plant at Big Lake, near Edmonton, where a 50-year supply of marl exists. The plan embodies use of feeder pipes and pipeline transportation.

A combination of lake water, marl and other ingredients, while in transport would carry out the initial production providing slurry for cement production. The pipeline in this way would deliver basic materials to the plant.

Month to Month

News of the Institute and the Profession

COMMENT AND CORRESPONDENCE
ELECTIONS AND TRANSFERS

The Canadian Conference on Education

An event unique in the annals of education in Canada will take place next February when about five hundred delegates will meet in Ottawa to focus attention on the objectives and needs of education in Canada in the next decade, and to seek ways and means to meet those needs. This conference is described briefly on p.1163 of the August 1957 issue of *The Engineering Journal.*

As one of the nineteen national organizations that are sponsoring the conference, the Engineering Institute of Canada is once again assuming the broader national responsibilities that must devolve upon groups of citizens who are banded together in associations by virtue of their special training and experience. Recent events have shown that professional men and leaders of business and industry are competent to consider our educational system, and groups such as the Engineering Institute have a fresh viewpoint and a large amount of useful background which enables them to make a real contribution — far more valuable than money — to the solution of Canada's problems in education. This is particularly true since it is generally believed that most of the difficulties are common to all, and are quite unspecialized.

In effect, the forthcoming conference will be a microcosm of our population, meeting with the objectives of:

(a) Having a truly representative group of Canadians attempt to define and delineate their common problems in education. It is hoped that this will be done in a realistic manner, devoid of "scare talk", and without passion or hysteria;

(b) Bringing the facts concerning these problems to the attention of the Canadian public. Since the conference is definitely not designed to cry havoc, it may be very opportune in averting any feeling of panic by its realistic approach. Conveying the true facts to the public should result in added emphasis on the ability of the Canadian people, and especially of the organized segments of our society, to face up to and solve our problems in education.

(c) Determining which of the problems can be approached on a common basis, and which may be best undertaken by specialist groups, and what the specific role of each group is to be.

Study of Nature Problem

Before the conference can function effectively, there must be the assumption that all participants come with an open — not vacant — mind. Only by this means will there be a chance of learning the true nature of the problems and of making an honest assessment of the various roles and functions necessary for their solution. This may, of course, require a re-alignment of many preconceived ideas, and much of the basic thinking that has been indulged in vis-a-vis Canadian education. And there will emerge a number of differences of opinion about what is lacking and what the remedies should be. It is hoped that these necessary differences will be construed by others as a sincere desire to help, rather than as criticism.

Finally, it is hoped that the consummation of the conference will not be confined to the process of some people passing a series of resolutions and briefs to other people. Rather, delegates should bring back to their sponsoring organizations the story of what has happened, giving a clear indication of the tasks that may best be undertaken by them. After all, we do have a responsibility to take action in this area, since we are talking about the future of our own sons and daughters, and about conditions in the neighbourhood school just down the street.

Cover Picture

The cover picture is typical of the "northern scene" being described by authors in this issue, showing icebergs and beach tanks at site of a northern construction operation.

Photograph courtesy of Foundation Company of Canada Limited

Student Membership Drives

The student representatives of the Institute at the University of Toronto and at the University of British Columbia began their drives to recruit new Student members during registration week.

The accompanying photograph shows Norman Seagram, S.E.I.C., distributing Institute literature to a registering student at the University of Toronto. The display shown was part of a well-organized campaign, conducted under Mr. Seagram's supervision, to encourage engineering students to join the Institute. Mr. Seagram, besides being the E.I.C. student representative on the campus, is also director of professional relations for the Student Engineering Society at the University.

The Student Section of the Institute at the University of British Co-

Norman Seagram headed the student membership drive in University of Toronto. He is shown above, left.

lumbia conducted a successful membership drive under the direction of Shigeo Saimoto, the section president. By the first week of October, more than seventy applications had been received and a request sent to Headquarters for more literature and application forms.

The Sopron Forestry School

A year has elapsed since the School of Forestry of the University of Sopron, Hungary, was transferred to the University of British Columbia, after the Hungarian revolution of November 1956.

Now officially a part of the university, the Sopron forestry faculty is known as the Sopron division, faculty of forestry, with the status of a school parallel to that of the schools of architecture and physical education.

With the final result of the revolution to be evaluated by historians, the Sopron people have found a new life. Canada in turn stands to gain a number of able and enthusiastic foresters over the next four years. Although the Sopron division as such will then disappear, the work of those who were a part of it will contribute significantly to Canada's future.

Most classes in the division are being taught in the Hungarian language this year but some of the professors may be able to change over to English before the year is finished. Indicating their intention of converting to English as soon as it is possible to do so, they have been using English textbooks from the beginning. In addition to their own classes, Sopron students will receive a course of lectures on Canadian forestry from the faculty of forestry staff, aided by special lecturers. It is likely that they will mix with Canadians through the media of sports, clubs, and other student activities and will soon feel as though they "belong" to the University. An excellent attitude pervades the group and they are receiving full co-operation from other students in the somewhat difficult transition period with which they are faced.

Some of the Sopron instructors have registered in graduate work at the University in order to make the most of their opportunity for further education in Canadian conditions and methods. As Dean G. S. Allen has noted, their presence in classes will almost certainly have a stimulating effect. It is expected the faculty members will be assimilated into U.B.C. faculty of forestry. Industry leaders have plans to provide Sopron students with forestry projects.

In spite of somewhat disappointing employment situation this summer, most of the Sopron professors and students found work in forestry, logging, or related fields. Many government departments and companies co-operated in helping to place the Hungarians and, as a result, they have acquired some good experience under our conditions, a better facility with the English language, and some savings to help see them through the University year.

Plans for housing the Sopron group have changed. Instead of operating a camp for them at the R.C.A.F. base at Sea Island, the government decided to encourage them to find private accommodation which would allow closer contact with Canadians. The Sea Island base is being operated

Dean Kalman Roller of the Sopron Forestry School is at right foreground in this photograph. In the group, from his left, are D. Udvardy, interpreter, U.B.C. zoology, Dr. F. Tusko, Sopron, John Phillips, U.B.C. Student, Dr. Jablanczy, Sopron, G. S. Allen, U.B.C. dean of forestry.

only as an assembly center until all can find other accommodations. Then it will cease to function. Classes began on September 23. Lectures are being held between 2.30 and 5.30 p.m., and laboratories between 6.30 and 9.30 p.m. In this way, university facilities are made available without adding to the already crowded conditions in the university.

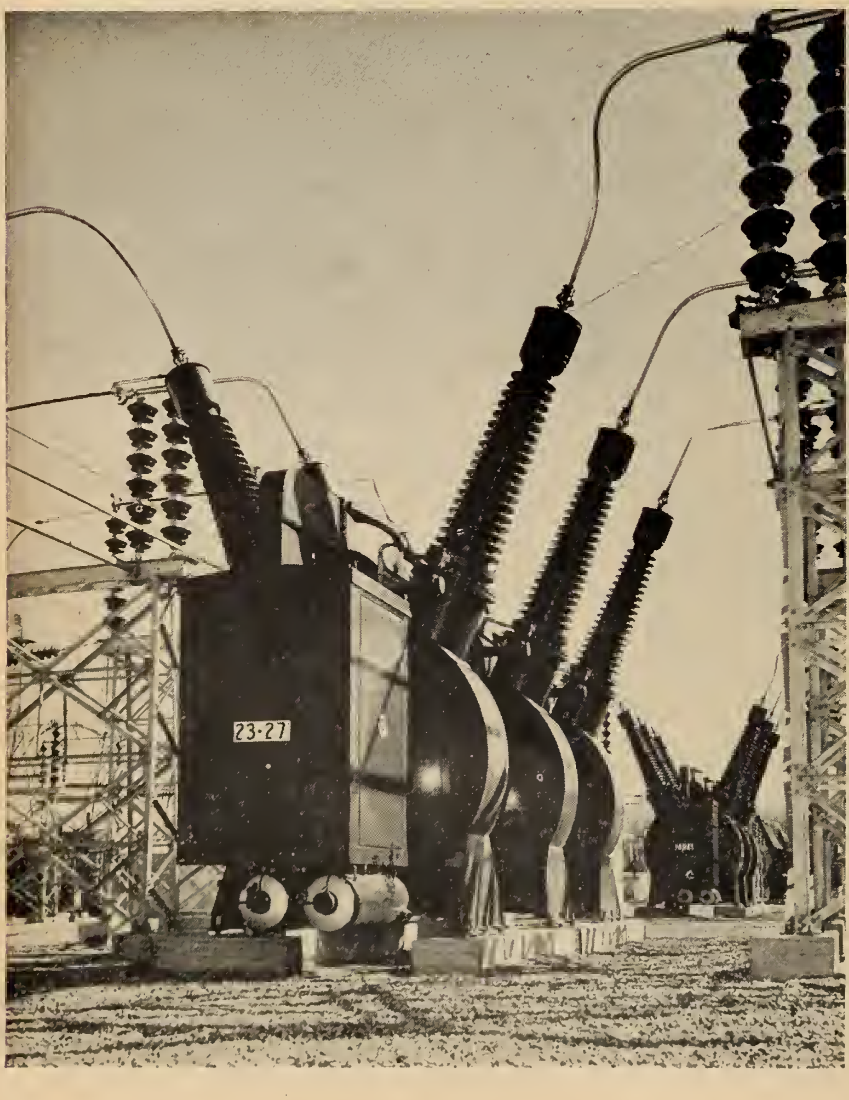
Of a truly proud tradition Sopron University stood with Kossuth in 1848 in the Hungarian War of Independence. The professors were the technical consultants of Kossuth and they were the leaders of their own students who fought in the Hungarian army. When this first war of independence was crushed by the Russians, the school was closed only to re-open again one year later. After World War I Hungary was cut to pieces and Selmesbanya, the location of the school at that time was ceded to Czechoslovakia. The forestry school moved, lock stock and barrel to Sopron. It functioned uninterruptedly and with distinction for many years, until the advent of the Soviet regime. The active part played by the Sopron staff and students in last year's revolution was the reaction to twelve years of oppression, and it made flight inevitable. The forestry group included 200 students, 40 of whom were women, 17 faculty members and 65 wives and children.

The story of the transfer of the whole group to British Columbia is well known. The university, the federal and provincial governments participated, with the Powell River Company providing temporary accommodations at Powell River.

Dean Kalman Roller who brought the group to Canada had this to say for his foresters, "It is not an everyday occurrence that the students and staff of a university leave their own country to find a new home in order to be able to preserve their ideal of freedom and to live as free men. I believe I am not conceited when I say that our exodus shall be written on the pages of history to provide example and inspiration for generations to come."

Information for this item was obtained from U.B.C. and from an article in *American Forests*, May, 1957.

"230-kv. Oil Circuit Breakers". Entry of The British Thompson Houston Co. (Canada) Ltd., to E.I.C. Photographic Exhibit, 1957.



Papers for the Annual Meeting Quebec City, 1958

It is Council's wish to make it known to the membership that papers are being sought for the annual meeting in Quebec City next May. The Papers Committee is ready to receive suggestions or submissions, which should be addressed to Headquarters.

J. H. Budden, is chairman of the Papers Committee; members are D. H. Hobbs, H. L. Johnston, M. McMurray, W. B. Pennock, E. R. Smallhorn, H. S. Van Patter and L. P. Bonneau.

The program for 1958 meeting is already under way, with several papers in the approval stage. Since the meeting is in Quebec, a fair proportion of the papers should deal with developments in this province. If any are available in the French language, they will be welcomed by the Committee.

Elections and Transfers

At a meeting of the Council held in Seven Islands, Que., on September 20, 1957, a number of applications were presented for consideration and on the recommendation of the Admissions Committee, the following elections and transfers were effected.

Members: D. R. Best, Montreal, J. Bordan, Montreal, F. L. Brown, Montreal, H. B. S. Brownlow, Corner Brook, G. P. Dandois, Montreal, R. J. O. Daoust, Edmonton, R. G. Edkins, Ottawa, J. C. Gateman, Calgary, B. G. Goodings, Toronto, J. T. Kokotailo, Toronto, E. G. Lester, Toronto, M. G. Lockwood, Texas, B. Nebesar, Copper Cliff, G. T. Page, Montreal, N. J. Pappas, Montreal, F. J. Riendeau, St. Johns, Que., J. C. H. Roberts, Quebec, R. P. Rowe, Ottawa, W. T. D. Shaddick, Kingston, E. C. Smith, Toronto, H. M. Smith, Sackville, E. A. Steinbrink, St. John's, Nfld., G. C. Wallace, Vancouver, J. S. Wexler, Montreal, A. H. Younger, Fort St. John, B.C., V. Zachanko, W. Pakistan.

Juniors: A. Antrobus, Port Arthur, A. J.

The delegates to a recent meeting of the Engineering Draughting Practice Committee of ABC are shown here at Toronto.

Leopard, Montreal, D. O'Sullivan, Hamilton, C. M. Papion, Montreal, P. F. Phelan, Peterborough, J. Rutherford, Montreal.

Junior to Member: J. W. Brison, Windsor, H. P. Connor, Hamilton, R. A. Harnois, Quebec, A. M. Ibrahim, Port-of-Spain, A. D. North, Montreal, C. R. Parke, Montreal, G. W. Spratt, Vancouver, J. S. Williams, Montreal, B. Yarymowich, Quebec.

Student to Member: J. J. Booth, Montreal.

Student to Junior: P. E. Coulter, Toronto.

Students Admitted:

McGill University: M. W. Brodie, E. G. Naismith, A. S. Skinner.

Queens University: C. E. Kropp, H. M. Sanchez.

University of Toronto: P. R. Falby.

Student A.P.E.O.: B. D. Reigler.

Graduate: I. McDougall, B.Eng.Elec., N.S.T.C., 1957.

Applications through Associations

By virtue of the co-operative agreements between the Institute and the Associations of Professional Engineers, the following elections and transfers have become effective:

ALBERTA

Member: G. C. Duthie; **Junior to Member:** M. M. Bright.

SASKATCHEWAN

Members: J. A. Chamberlain, A. E. Fraser, J. A. Harvie, W. L. Payne, F. C. Pickard, A. D. Scharf, B. A. Steuart, G. R. Stewart, V M. Whelen; **Junior to Member:** J. W. Campbell, I. F. Rogers; **Student to Junior:** H. M. Hill, C. A. Ing, T. J. Moynihan, W. J. Serne.

NEW BRUNSWICK

Junior to Member: L. H. Clifton.

NOVA SCOTIA

Member: D. A. Kean; **Junior to Member:** R. A. Bradley, A. B. Chisholm, G. P. Miller.

MANITOBA

Member: C. Vogel.

Engineering Draughting Practice

Statement of the chairman, Engineering Draughting Practice Committee of America-Britain-Canada on conclusion of sessions, October 7-11, 1957.

Delegates from America-Britain-Canada at Toronto have examined and considered the respective publications of these national standards bodies relating to engineering drawing practices, namely, American Standards Asociation Y14, 1-6; British Standards BS308; and Canadian Standards Association, B78.1.

The delegates have propounded recommendations, the implementation of which will eliminate any significant difference in principle so that drawings prepared in accordance with any one of these standards, when amended, will be capable of being readily understood and used in the factories of the countries.

This is the succesful culmination of a project which has been patiently pursued for some twelve years.

The result will greatly facilitate exchange and mutual understanding of designs and manufacturing data amongst the countries concerned, and eliminate the necessity for preparation of fresh drawings. By providing designers with a common form of technical communication, the results of this session should lead to lower costs and improved security. In a state of emergency, it will permit the assignment of component manufacture between the three countries, to take advantage of their manufacturing facilities, and so achieve maximum production.

A. N. Huddleston, Lt. Col.
October 11th, 1957.

History of ABC

ABC was originated by the Combined Production and Resources Board of America-Britain-Canada during World War II for the purpose of expediting the best possible use of materials, etc. The representatives were then Mr. William Batt, (USA), Sir Henry Field (Britain), and the Right Hon. C. D. Howe, (Canada).

The first major project of this committee was the unified screw thread.

The object of these 1957 meetings at Toronto has been to continue the unification of the engineering draughting practice standards of each of the three countries.

Those heading the delegations were: *America:* Prof. R. P. Hoelscher, General Engineering Department, University of Illinois; Urbana, Ill.; *Britain:* T. R. Houston, English Electric Company Limited, Rugby, England; *Canada:* Lieut. Col. A. N. Huddleston, Canadian Army, Ottawa; *Sessions Chairman:* Lieut. Col. A. N. Huddleston; *Deputy Sessions Chairman:* George Noble, Dominion Engineering Company Limited, Montreal.

Steering Committee: *America*, Louis Polk, Sheffield Corp., Dayton, Ohio; *Britain*, Stanley Harley, Coventry Gauge & Tool Co., Coventry; *Canada*, James G. Morrow, Steel Company of Canada Limited, Hamilton.

THIRTY-FIVE YEARS AGO

Comment on the Journal of November, 1922

Today's gaily-coloured covers of the *Journal* are in pleasant contrast with those of thirty five years ago, which bore the same modest buff-coloured cover month after month, inscribed only with the E.I.C. shield and the words: "To facilitate knowledge among its members, to promote their professional interests, to encourage original research, to develop and maintain high standards in the profession and to enhance the usefulness of the profession to the public".

Today's issues average over a half inch in thickness, compared with issues half as thick in the 'thirties'. This reflects Canada's population growth from 11 million in 1935 to 16½ million today. It also reflects the nation's greater industrialization and its economic growth in the increased number of its pages of advertising, technical papers, and other reading matter. The number of Branches of the Institute has more than doubled as well.

New classifications of engineers have appeared such as petroleum, petrochemical, aviation, town-planning, radio, electronic and nucleonic —to mention only a few. Reading matter must now include subjects of interest to these groups. Members today seek to know what their fellow engineers are doing in other branches of the profession. They are keen to learn more about the exciting engineering developments that are at once the cause and the effect of Canada's current spectacular growth.

The November 1922 issue contained three technical papers: — "Valuation of Public Utilities", by R. A. C. Henry, M.E.I.C., "Fuel Problems of the Steel Plant" by E. E. Litz, M.E.I.C., and "Accident Prevention in Industrial Plants", by W. G. H. Camee, A.M.E.I.C., A report of the Committee on Classification and Remuneration of Engineers by its chairman A. H. Harkness defined the duties and qualifications for various grades from assistant chief engineer to junior aid. Ranges for proposed minimum and maximum yearly salaries were given as follows: — assistant chief engineer, $7,200 — no limit; grade II engineer, $5,400 — no limit; grade III senior assistant engineer, $4,200-$5,400; grade IV asistant engineer $3,300-$4,200; grade V junior assistant engineer, $2,400-$3,300; grade VI junior, $1,800-$2,400; grade VII senior aid, $1,200-$1,800; grade VIII junior aid $600,-$1,200.

In the editorial section were listed by-law amendments being prepared with respect to constitutional changes by the Legislation and By-Laws Committee of Council. Attention was called editorially to the prestige gained for the profession through the recent appointment by the federal government of Sir Henry Worth Thornton, K.B.E., an outstanding engineer, as president of the Canadian National Railways System.

Elections and appointments of members were noted as follows: A. L. Clark, Ph.D., B.Sc., dean of the Faculty of Applied Science of Queen's University was elected an Honorary Member of the Institute; S. J. Hungerford, M.E.I.C., was appointed vice-president and general manager of the Canadian National Railways System; H. S. Van Scoyoc, M.E.I.C., was appointed president of the Association of Canadian Advertisers; G. J. Desbarats, C.M.G., M.E.I.C., was promoted to the position of deputy minister of public works for Manitoba.

The Branches

The Saskatchewan Branch reported papers on "Waters of Saskatchewan for Boiler Purposes", "Highway Investigations and Specifications", and "Some Notes on Irrigation".

Subjects discussed by the Ottawa Branch included a paper on "The Automatic Control of Fire", by J. Grove Smith, B.Sc., F.R.S.A., Dominion Fire Commissioner, who pointed out that destruction of property in Canada in 1921 had caused an expense of $5.25 per capita, ten times greater than in any other country except the United States, resulting in insurance rates 5 to 10 times higher than in other countries. Fires had cost 300 to 450 lives yearly.

The London Branch reported an inspection tour of various points of engineering interest in that city, including waterworks, garbage incinerator, paving plant, sewage disposal and pumping station. The Moncton Branch had been addressed by W. C. McMullen of the New Brunswick Department of Lands and Mines, who dealt with mines and minerals of that province. The Cape Breton Branch heard a paper by K. M. Cameron, A.M.E.I.C., and S. C. Mifflen, A.M.E.I.C., on "Present Day Practice in Concrete Construction". Calgary and Niagara Branches heard papers relating to highways.

The Vancouver Branch recorded a tour of inspection of the Sumas reclamation project under the guidance of the Hon. E. D. Barrow, minister of the B.C. Department of Agriculture, and F. W. Anderson, M.L.A., A.M.E.I.C. The project involved the drainage of Sumas Lake and some 30,000 acres of arable land which was inundated during flood periods of the Fraser and Vedder rivers.

An active town planning committee was formed by the Branch, with the purpose of drafting a proposed town planning act. Efforts of this committee were rewarded by the proposed act receiving endorsation of the Union of British Columbia Municipalities at its annual convention.

Under 'Other Societies News', Calvin W. Rice, M.E.I.C., reported on his attendance as representative of the Institute at the International Engineering Congress at Rio de Janeiro in September. A council meeting of the Canadian Institute of Chemistry was held September 20 at E.I.C. Headquarters at which it was decided to work out an organization on a professional basis, and to hold organization meetings in Ottawa, Toronto and Kingston. Membership was reported at 277. The Legislation Committee had under preparation a model bill for the use of chemists in any province where it might be desirable to seek legislation, H.G.C.

Correction

The cartoon published on Page 1495 of the October issue of *The Engineering Journal* should have been accompanied by the following notice: **Drawing by Dedini, Copr. 1957 The New Yorker Magazine, Inc.**

The omission is regretted by the editors, and the co-operation of *The New Yorker* is gratefully acknowledged.

So You're Going to "Read" a Paper

Harold O. Haskitt, Jr.,
General Motors Institute, Flint, Mich.

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WITH YOUR PERMISSION I'm going to assume that you have been asked to "present" or "read" a "paper" at a convention session of your primary technical society. Your topic has been selected and the session chairman has indicated a definite time limit. Now what do you do? If you are like most of us, you will probably get your notes together, *write* your "paper", have it mineographed, run through it aloud a time or two and then present it at the meeting by reading it in a none-too-effective way to your disappointed peers.

When you have finished, you breathe a sigh of relief and comfort yourself with the thought that you have made copies of the "paper" available in printed form—just in case someone didn't understand or remember what you had to say. If this has not happened to you personally, you perhaps can recall similar instances in convention situations where you have been the "listener" to such a talk. After such sessions you may have had the feeling, either as speaker or listener, that somehow it might have been better.

Somehow you were not satisfied that a good job of communicating had been done. But before you could get around to doing much thinking about how it might have been improved, you became involved in other activities and responsibilities which crowded it out of your mind until the next convention or the next speech. Toward the purpose of seeing what the speaker might do before his next talk, let's take a look at some of the elements in the complex process of getting ideas across to individuals in an audience.

Communication not presentation, of ideas involves more than the transmission of thoughts by you as a speaker to or at a listener. At almost the same instant that the listener is receiving the thought-content of the talk, he is also receiving clues which he uses to build an evaluation of you as a person: professional expert, colleague, and fellow human being.

These things directly affect his feelings and attitudes as a listener, and may well determine how much of the thought (content) he understands and carries away with him. When an audience member goes away from a convention meeting saying, "I came to hear the *man*, not just his paper. I could have stayed at home and got more out of it by reading the speech myself," isn't he saying to a speaker, "I want to know both *you* and your ideas — please talk *with* me on a person-to-person basis, not *at* me as if I were a cabbage-head?"

The fact that in listening, a person *feels* at the same time that he *thinks*, accounts for the fast-growing use over the past few years of the extemporaneous method of speech delivery. Each listener wants to feel that the speaker is carrying on a friendly, highly spirited, organized conversation with him (and others in the group) on a subject which is highly informative and interesting to both parties in the discussion. Now, what can a convention speaker do to improve his chances of communicating effectively? The following may suggest ideas to you which you may find at least worth thinking about if not worth actually using at some time.

Know Your Subject

It is almost too obvious that a good communicator must be saturated with his subject. The concepts you are going to discuss should be so thoroughly thought through that you will have no difficulty in capturing and recapturing the bases for each main point and its supporting details at the time you are bringing them out. Each idea expressed should stem from a clear-cut basis in thought, and, whenever possible, your visualization of ideas expressed should be vivid and intense.

Even the words you use should be carefully selected in terms of the pictures, concepts, and interest that they arouse, both in the speaker *and* the listener. For, generally speaking, the more a speaker knows and the sharper his perceptions are about a subject, the more interested he becomes in it, until he actually finds himself anxious to share it with others.

Organize For Your Listener

Body of the Talk. The main reason for organizing material is to help the listener understand it more completely, more rapidly, and more easily, even with a minimum of effort. This means then that the subject matter should be put together in a structural pattern which the listener can recall easily later on, and which he can recreate quickly for himself as the speaker is talking.

Main points should be limited in number (no more than five), and worded in a concise, clear, and interesting way. Explanations, illustrations, facts, and other supporting materials for these principal ideas should be selected to capture the greatest listener interest and understanding in the limited time allowed the speaker. If certain content materials will cause audience interest to lag, they should be simplified, eliminated or presented in a different way.

Introduction of the Talk. The function of the introductory portion of a speech is to get the audience warmed up and in a receptive frame of mind to understand and accept the main ideas to be brought out. During this period a listener is very busy trying to focus his attention and to evaluate the elements that go to make up your particular personality. At the same time, he is trying to establish in his mind the specific central idea and your approach to it so that he can build his own "speech" as the talk unfolds.

So, sufficient time should be spent in developing whatever is used to arouse interest and lead into the main subject so that the audience can establish a favourable and receptive listening attitude. In addition to stating the central theme, some indication as to how you intend to develop the subject may help the listener in recognizing relationships between ideas as the speaker progresses.

Conclusion of the talk. Develop the conclusion so that the central and main ideas are clearlv reinforced. Audience interest should be maintained at a high level right up to the last syllable.

Write and Re-Write

A paper that is to be published as an article after it is delivered as a speech will involve re-writing at least twice, and perhaps more — first as an article, then as a speech. Re-writing during the preparation of the article allows you to weigh and select words carefully, to cast them into phrases and sentences which will carry the precise meaning you want to convey to your *reader.* If you try to use the written paper as a manuscript from which to speak, however, you may have some difficulty.

Normally, the way we write and the way we speak differ considerably, primarily because of the contrast between a reader's situation and that of a listener at the time each is receiving the information. If a silent reader doesn't understand what is written the first time he reads it, he usually has time to go back and re-read a given sentence, paragraph, or even page before he goes on the next unit. A listener, by contrast, has no "second chance," so-to-speak. He must get the speaker's meaning immediately because he usually cannot or does not ask the speaker to stop and repeat so that the puzzling sentence or unit can be "re-heard."

This obviously means that a speaker's language must be as simple and concrete as possible, his sentences relatively short, and his organizational pattern easy-to-follow if he is to communicate successfully. If you are going to read your paper aloud, consider re-writing it in the language and style you personally use in speaking, so that you will be direct and conversational in your approach to the audience. Incidentally, you may be surprised how much easier it is not only on you but also on your listeners.

Sharpen Your Speech Delivery

In the actual delivery of the speech there are obviously two major methods available to you, both of which are equally effective if done well. One, already mentioned, is to use the written paper in developing a speech manuscript suitable for easy, conversational, oral reading. The other is to speak from a brief outline or notes.

During the preparation stage of either of these two methods, one way to assure coverage of all the main ideas and supports, and at the same time to find the best way for you to express these ideas aloud, is to develop a good old-fashioned outline in standard form, including introduction, body, and conclusion. If you use the first method of delivery (speaking from a manuscript) it will help you to find and decide upon certain word choices and ways of putting sentences together which will allow you to be conversational and direct with your audience. The resulting style will make it much easier for you to feel and *think* the ideas *as you are reading the words.*

Once you have settled upon the exact wording and sentence structure for the completed speech manuscript, it should be rehearsed aloud word for word, with as much meaning and real feeling behind the ideas as you can get. Continue revisions until you are satisfied that the manuscript will allow you to be yourself.

A tape recorder can be an excellent aid to you, not only in the process of developing the final speech manuscript, but also in improving the way you read it aloud. If you record your practice readings and listen carefully to the playbacks, you will hear many things which will encourage you. You may also hear a few things you might like to change, such as putting more emphasis upon certain important ideas, developing more speaker-interest in parts or even throughout the talk, or sharpening your person-to-person manner of talking while you read — to mention only a few.

If you find it easier to maintain audience interest by speaking from a brief outline or notes, the use of a tape recorder during practice sessions will give you additional help in spotting areas where you may wish to strengthen your own concepts, or perhaps make even better use of your voice in getting the intended meaning across. A few such recording and playback practice sessions can be very rewarding.

"See" Each Listener

During the actual delivery of the talk at the meeting, a speaker needs his own continuous index of "feedback". That is, he *must establish and maintain* definite *eye contact* with as many individuals as he possibly can during the speech, so that each person will feel that *he* individually is being included in the speaker's audience. By this means you can evaluate your own progress and success in getting your thoughts and feelings across and you can adjust accordingly as you move along. When visual aids are used, you should be so familiar with their nature and content that good eye contact with the group can be maintained even while working with the aid.

One last word about the speaker's *enthusiasm* both before, and on the day of the talk. You not only should check your visual aids and other materials before the meeting time, you should also prepare yourself psychologically. Your feelings of friendliness and enthusiasm about your subject matter and the opportunity to share it with your peers in this particular group of associates and other professional people must be so vital and intense that they will be infectious to everyone, even those in the back row. Let the group share with you the proper pride you have in your subject, your chosen profession, and in your status as a fellow human being.

A little spontaneous feeling can send a thought a long way.

NEWS OF THE
Associations and Corporation

Information received through co-operation of the provincial organizations.

BRITISH COLUMBIA

Municipal Engineers Convene

Paramount importance of engineering services to the community was stressed by Major - General C. A. P. Murison, Reeve of North Cowichan, B.C., in his keynote address at the annual banquet of the B.C. Municipal Engineers' Convention in Victoria, September 13.

The Big Five

"The big five services for which local government is responsible," he said, "are Education, Health and Welfare, and the three engineers' services — roads, water, and sewers. While the first two only affect some of the people some of the time, the last three concern all of the people all the time."

Stating that the dominating factor is finance, he reviewed the statutory obligations, over which local councils have no control, for devoting most of their budgets to Education and Health and Welfare. While municipal funds derive from taxes on property, they must be mainly spent on services to people which, General Murison contended, should be more logically provided by provincial and federal revenues. Services to property are thus caught in a squeeze which gets tighter with the growing demands of our expanding communities, the practical limits of property taxes, and the increasing requirements of social services.

Citing the aggregate municipal revenues in B.C. for 1955 as $91,000,000.00, he said that 21% was ear-marked in advance for school boards, and only 11% or $9,750,000.00 was left over for essential public works. His conclusion was that a more equitable distribution of provincial and federal revenues must be obtained from the senior governments.

General Murison then traced the problems of municipal administration, with penetrating comments and advice on the separate functions of elected and permanent officials, in an address that was remarkable for spontaneous humour and polished delivery as well as for thorough knowledge of the subject.

Members of the 1957-58 executive committee of the Municipal Engineers' Division of the Association of Professional Engineers of British Columbia elected at their convention in Victoria, September 13-14 are: seated, left to right, H. D. Dawson, P.Eng., of Saanich, past-president; G. P. Harford, P.Eng., of Prince George, chairman; A. S. G. Musgrave, P.Eng., of Oak Bay, honorary secretary; T. G. deWolf, P.Eng., Vernon. Standing, left to right are: J. F. Millican, P.Eng., Tadanac; J. A. Merchant, P.Eng., of Vancouver, secretary; H. T. Libby, P.Eng., Vancouver; A. G. Shore of the Municipal Suppliers Association. A. Stewardson, P.Eng., of New Westminster is not shown in the photograph.

Three Hundred Attend

This was just one of many highlights of the 15th annual meeting of the Municipal Engineers' Division of the Association of Professional Engineers of B.C. A total of 300 people, including municipal engineers, public works officials and suppliers were in attendance from 50 B.C. communities as guests of Saanich Municipality. Sessions were held in the Empress Hotel, Victoria.

On September 12 a number of delegates, under the guidance of their hosts, visited the Federal Dry Dock at Esquimalt, Victoria's new Point Ellice Bridge, and municipal installations in Saanich and Oak Bay.

The following papers were read and discussed: "Air Pollution Control" J. Satterthwaite, Smoke Inspector, City of Vancouver; "Storm Water and Open Channels" D. A. Welsh, assistant municipal engineer, District of North Vancouver; "Photography and Records", H. T. Libby, Manager, Gas Distribution Dept., B.C. Electric Co. Ltd., Vancouver, B.C.; "Location of Utilities", D. A. Whelan, Associated Engineering Services Ltd., Vancouver, B.C.; "Time and Method Study for Municipal Engineering", L. B. Kellogg, Stevenson and Kellogg Ltd., Vancouver; "Uses of Asphalt as Applied to Smaller Municipalities", S. J. Cunliffe, Partner, Willis & Cunliffe, Consulting Engineers, Victoria, B.C.; "Administration and Management", J. C. Garnett, City Engineer, Victoria, B.C.

General Chairman was H. D. Dawson, retired municipal engineer of Saanich.

Next year's convention will be held in Prince George, under the chairmanship of George P. Harford, P.Eng., City Engineer. Elected to the 1957-58 executive committee were: George P. Harford, P.Eng., (Prince George), chairman; H. D. Dawson, P.Eng., (Saanich), past chairman; T. G. deWolf, P.Eng. (Vernon); H. T. Libby, P.Eng., (Vancouver); A. Stewardson, P.Eng., (New Westminster); J. F. Millican, P.Eng., (Tadanac); A.S.G. Musgrave, P.Eng., (Oak Bay), Hon. Secretary; J. A. Merchant, P.Eng., (Vancouver), Secretary.

Engineers in the News

John E. Liersch, P.Eng., past president of the Association, has been appointed to the newly-created post of executive vice-president of the Powell River Company Limited. He has been vice-president in charge of forestry and logging operations for the company since 1950. Before the war Mr. Liersch was head of the forestry department at the University of British Columbia; during the war he was granted leave of absence to work for the Dominion Government in turning out spruce for mosquito bombers. In 1947, he joined the Powell River Company and has been a member of the Association since 1936.

R. C. Herman, is attending a school of international business administration in Geneva for a year beginning in September. His address is c/o Centre d'Etudes Industrielles, 4 Route de Drize, Geneva, Switzerland.

J. A. C. Ross, P.Eng. a mining engineer, has resigned from his position as general manager of The Granby Consolidated Mining, Smelting and Power Co. Ltd. With the permanent closing of the Copper Mountain Mine, Mr. Ross chose to resign rather than remain with Granby and assume a position of lesser responsibility. He intends to take up permanent residence in Vancouver, B.C. Before seriously considering other employment, Mr. Ross will be attending the "across Canada" tour of the Sixth Commonwealth Mining and Metallurgical Congress.

J. M. Hunter, is now employed by the B.C. Telephone Company.

Grant Irwin a graduate of U.B.C. in 1956 in mechanical engineering, has taken a position with Dominion Bridge Company, Limited.

William R. P. Porter, P.Eng. of Toronto has been appointed general manager of Lucky Lager Breweries Ltd. Mr. Porter is a graduate of the University of Toronto in mechanical engineering. He has had previous experience in British Columbia in the brewing, lumber, and plywood industries.

ONTARIO

Engineers In The News

W. J. M. Redwood, P.Eng., safety engineer of the Algoma Steel Corporation, Sault Ste. Marie, Ont., has been honoured for his many years of public service through the St. John Ambulance Brigade by appointment as a Serving Brother of the Order of St. John.

The official communication from the Priory of Canada reads as follows:

"Her Majesty the Queen, the Sovereign Head of the Grand Priory in the British Realm of the Venerable Order of the Hospital of St. John of Jerusalem, has been graciously pleased to sanction the admission of W. J. M. Redwood as a Serving Brother of the Order of St. John."

Mr. Redwood has been safety engineer with Algoma Steel since moving to Sault Ste. Marie some 15 years ago. A past president of the Soo Safety Council, he was previously honoured by being presented with the King George VI Coronation Medal for his work on behalf of ex-service men and women.

J. D. Barrington, P.Eng., formerly president and managing director of Polymer Corporation Ltd., Sarnia, Ont., has become president and managing director of Ventures Limited with his headquarters in Toronto.

After his graduation in mining engineering from the University of Toronto in 1926, Mr. Barrington held many important positions in mining, metallurgical and petrochemical fields. In 1951, whilst vice-president and general manager of Dominion Magnesium Ltd., he was asked by the Canadian Government to become president of the Crown-owned Polymer Corp. Ltd., in Sarnia. In the succeeding years he played a very important role in the expansion of this organization.

G. L. Wilson, P.Eng., formerly with E. M. Powell & Associates Ltd., of Sudbury, Ont., is now with Sprostons Jamaica Ltd., a subsidiary company of Aluminium Company of Canada Ltd.

Mr. Wilson is in charge of civil engineering relative to the construction of a five-mile cableway which will carry bauxite ore from the mine, over a mountain, to an alumina plant under construction at Ewarton, Jamaica, some 30 miles from Kingston. Alumina will be shipped to Kitimat, B.C. for smelting.

Ross A. Ritchie, P.Eng., has recently been appointed vice - president, manufacturing, of the Electric Reduction Company of Canada Ltd., Toronto.

J. Craig Cringan, P.Eng., has joined the engineering design department of Atomic Energy of Canada Ltd., at Chalk River, Ont. A graduate in engineering of the University of Toronto, 1948, Mr. Cringan was previously employed by the Factory Mutual Engineering Division as resident engineer for Western Ontario.

Edward P. Innes, P.Eng., of Hamilton, Ont., has been elected a director of Canners Machinery Limited, Simcoe, Ont.

Mr. Innes is chief engineer of Canadian Canners Ltd., Hamilton. With the exception of service in the Canadian Army durng 1941-45, he has been associated with the firm since graduation from McGill University in 1934.

Geoffrey R. Pritchard, P.Eng., has been appointed general sales manager of Trane Company of Canada Ltd., Toronto and is responsible for the direction of the six departments within Trane's sales division—heating, air-handling, air

L. D. Wickwire, vice-president of the Association of Professional Engineers of Nova Scotia extends an official welcome on behalf of the Association to C. M. Anson, president of the Engineering Institute of Canada, on the occasion of his tour of the 48 branches of the Institute. Council of the Association were luncheon hosts to the E.I.C. president and general secretary following which Messrs. Anson and Wright and other distinguished guests attended a Council Meeting of the Association.

conditioning, advertising, sales promotion, student training and export.

Mr. Pritchard graduated in engineering from the University of Manitoba in 1937. For ten years he served as a sales engineer with Canadian Allis Chalmers. Prior to joining Trane he was with John Inglis Company for ten years, latterly as general manager of the refrigeration and air conditioning division.

E. de Haas, P.Eng., formerly cable maintenance engineer with Ontario Hydro, Toronto, has accepted a post with the U.S. Atomic Energy Commission in connection with a four-year project for building a nuclear accelerator at Princeton University, Princeton, N.J. Mr. de Haas, who is now located at the Palmer Laboratory in Princeton, is responsible for the power-electrical design.

J. David V. Adams, P.Eng. is in London, Ont., where he is taking the course in business administration at the University of Western Ontario. Mr. Adams, who graduated from McGill University in 1955 was previously with the design group of Canadian Industries Ltd., Kingston, Ont.

QUEBEC

New Tariff of fees Approved

The result of a joint effort of the committees on Tariff of Fees of the Ontario Association and the Quebec Corporation, the new Tariff has been used in Ontario for some three years now and was submitted to the approval of the membership in a referendum in 1955. Following its approval by the membership it had been presented to the Provincial Government for the official sanction of the Lieutenant-Governor in Council. Legal difficulties prevented its adoption until these could be solved last summer.

Salary Survey Aid

Montreal city authorities have given the Corporation assurances of cooperation in the conducting of a survey on the salaries of the engineers in its employ. Said survey is to be undertaken by the Corporation's Specialized Services Officer, B. R. Lachapelle, P.Eng., M.Sc., A petition was received signed by almost all engineers employed by the City, requesting the help of the Corporation "in convincing the municipal authorities of the necessity for the well-being of the profession as well as of the public in general, of establishing the remuneration of municipal engineers on a basis comparable to that prevailing in other positions held by members of our profession."

Sherbrooke U. Extends Course

Sherbrooke University, which has been offering the first three years of the engineering course, for many years now, has decided to offer its students the last two years of the course as well. Curriculum has been submitted to the Corporation and the Board of Examiners has found it satisfactory. If all goes well, Sherbrooke University will grant its first degrees in engineering in 1959. The course will be of a general nature but in view of the growing industrial development of the Eastern Townships, will offer a certain amount of specialization in electrical and mechanical engineering.

Referendum on Requirements

Referendum on uniform registration requirements is currently being held. The Corporation has long since favoured Uniform Registration Requirements throughout Canada and appointed a committee to determine how these requirements could be implemented in Quebec. The committee's recommendation was that the Professional Engineers' Act be amended to establish a class of "Junior Professional Engineers" and require two years of satisfactory engineering experience before granting full professional rights and privileges. At present, full rights are granted upon graduation from a recognized university or admission to the Corporation by the Board of Examiners.

Problems to be Aired

Considerable headway has been made by the Corporation's Committee on the Advancement of the Employee Engineer towards solving the major problems facing employee engineers. The Committee which is just a little over a year old, already boasts of several accomplishments: the problems of employee engineers have been clearly defined and substantial progress has been made in the study of the more important of them.

It is particularly interesting to note a province-wide basis with sub-committees operating in most of the areas of the Province under the supervision of the Coordinating Committee, composed of the chairman of the various sub-committees. This remarkable organizational structure is unique in the history of the Corporation, and makes it possible for almost all Quebec engineers to express their views on the subjects under committee study. Experience has shown that a number of Quebec engineers have already availed themselves of this opportunity and it is expected that this trend will continue.

Study of Employment Contract

This year, the Committee is primarily concerned with an investigation into the possibility of the Corporation sponsoring an employment contract stipulating the conditions governing the relationship between the engineer and his employer. The Montreal and the Quebec sub-committees are both working on this at present and indications are that a final recommendation in this regard will be made to Council before the current Corporation year is over. A final draft of the contemplated contract form is just about completed and a meeting of management representatives will be called shortly in order to obtain management's reaction to the contract approach as well as an assessment by them of the clauses contained in the draft prepared by the Committee. It might also be necessary to call on the Legal Adviser for a proper evaluation of the legal implications of the conditions stipulated in the contract.

Booklet on Employment Practices

Another of the major objectives that the Committee set out to maintain this year is the preparation of a booklet designed to give graduating students in engineering some guidance in their job-hunting activities. The feeling is that there is a need for such guidance and that it would be to the best advantage of both the engineer and the prospective employer in eliminating eventual sources of discontent. It is hoped that the booklet will be ready for distribution to the 1959 graduates.

Training at University Level

The Committee is also busy working out details of a course at university level covering the Professional Engineers' Act, the By-Laws and Code of Ethics, the history of the profession, the criteria of a true professional life, etc. Every effort is being made to get the fundamentals of this course worked out in the near future so that university representatives can be presented with the idea at an early date.

Publicity to be released

The Committee is presently working on releases to go to the membership as well as non-engineers in management, outlining certain principles of professionalism which the Corporation considers as essential if the recognition of engineering as a profession is to be fostered. These releases will pertain to utilization of engineering talent, criteria of adequate professional attitude, acceptable employment practices, etc.

Sub-Committee Members

There follows a list of the P.Eng.'s who compose the various sub-committees:

Montreal—W. T. Clarke, chairman, also chairman of the co-ordinating committee; L. P. Camirand, J. F. Davison, P. Demers, C. R. Houle, P. McCallum, M. P. Simon, and D. Wermenlinger.

Lake St. John — J. J. M. Falardeau, chairman; A. H. Johnston, M. Lavallee, H. S. Monahan, and S. T. Solinski.

Eastern Townships — Roland Dugre, chairman; J. Bourassa, Y. Chabot, R. Laliberte, P. D. Normandeau, M. St. Jacques, and J. F. Whyte.

Quebec City — Marcel Latouche, chairman; J. C. Bedard, P. E. Begin, R. Bernier, P. Bousquet, J. B. Delage, J. D. Gorman, and P. H. Lavallee.

St. Maurice Valley — W. W. Ingram, chairman; and M. C. Caron.

Ottawa Valley — J. S. Sudbury, chairman.

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

Clifforde Graham Moon, M.E.I.C., retired civil engineer with the Ontario Paper Company, St. Catharines, Ont., died in that city on September 13, 1957.

Mr. Moon, who was born at Ottawa, Ont., on September 28, 1885 was educated at Ashbury House School, Ottawa, and had naval training in Great Britain. Later, returning to work at engineering in Ottawa he was an assistant in the city engineer's office. Within the next few years from 1903 to 1911 he held appointments at Prince Albert, Sask., as city engineer; as an assistant in the firm of Willis Chapman, Toronto, and as inspector and assistant engineer with the Canadian Pacific Railway at Winnipeg and Vancouver.

His participation in World War I, was with the 87th Royal Canadian Engineers. He was at war's end associated with the Grand Trunk arbitration board. Engaged on the construction of the Welland Ship Canal in the early twenties, he joined the staff of the Ontario Paper Company on completion of the canal. He retired in 1955.

Mr. Moon joined the Institute as a Student Member in 1907, transferred to Associate Member in 1911. He became a Member in 1940 and was elected to Life Membership in 1947.

Captain Frederick Anderson, M.E.I.C., retired civil engineer, head of the Canadian Government hydrographic service Department of Mines and Fisheries, from 1925 until his retirement in 1936, died at Ottawa on September 21, 1957.

Two days away from his eighty-ninth birthday at the time of his death, Captain Anderson was born on September 23, 1868 at Charlottetown, P.E.I. He attended the Royal Military College, Kingston, Ont., graduating in 1890. For the first few years civil engineer on surveying work in New York, N.Y., he returned to Canada to join the Canadian Government service at Ottawa in 1892. Directing survey operations in the Lake Winnipeg area for some time he subsequently was assigned to all of the Great Lakes save Lake Michigan, in American waters, Hudson Bay, Labrador, and the Nova Scotia coast.

During World War I he was actively in charge of defence charting for the Royal Navy along Canada's Atlantic ports, much of it having to do with anti-submarine installations.

Between 1910 and 1914 Captain Anderson pioneered the Hudson's Bay seaway route leading several expeditions responsible for locating harbour facilities at Port Nelson and Churchill. The first vessel specifically designed for hydrographic work in Canada was placed in commission under his supervision in 1913 and it was during his time that electronic sounders and air photography were first employed in Canadian hydrography.

Captain Anderson enjoyed the unique distinction of being a hydrographic surveyor qualified to handle his own ship.

Captain Anderson joined the Institute as a Member in 1909. Life Membership was conferred on him in 1946.

Leslie Gordon Jost, M.E.I.C., consulting structural engineer, for many years resident in Los Angeles, Calif., died there on September 24, 1957, following an illness which caused his retirement January 1, 1957.

A 1908 graduate of Acadia University, with a B.Sc. degree, he was two years later awarded a civil engineering degree from McGill University.

Mr. Jost moved to California in 1919 and held responsible design and executive positions with the Llewellyn Iron Works, Consolidated Steel Corporation, City of Los Angeles Building and Bridge Departments, and private consulting engineering firms. During the last ten years of his engineering practice he was president of a consulting structural engineering firm.

In his long experience in the engineering field Mr. Jost has been associated with many industrial and commercial structures housing airplane factories in the Southland.

Mr. Jost joined the Institute as a Student in 1909, transferred to Associate Membership in 1913, to Member in 1938. He attained Life Membership in 1948.

Will Malcolmson Stewart, M.E.I.C., former deputy-minister of highways for the Province of Saskatchewan died at Regina August 22, 1957.

Mr. Stewart was born at Hamilton, Ont., on November 26, 1884. After completing high school in that city he attended the University of Toronto and graduated from the School of Practical Science in 1906, in civil engineering. The following year he enrolled in a post graduate course at that college, receiving the degree B.A. Sc. in civil engineering in 1909. He was commissioned as a Dominion Land Surveyor in 1907, a Saskatchewan Land Surveyor in 1910.

He participated in the subdivision of townships in the Lloydminster area of the North West Territories, in 1904, and a venture by canoe from Prince Albert, Sask., the following summer, to Fort Churchill and Port Nelson on the Hudson Bay. He was engaged in exploratory work for the location of a railway chartered as the Hudson Bay, Prince Rupert Land and Pacific Railways.

A new graduate in engineering Mr. Stewart was engaged, from 1906 to 1912, on the Dominion land subdivision survey contracts in northern Manitoba and Saskatchewan. In 1909 the opening of an office in Saskatoon marked the beginning of a private engineering and land surveying practice in partnership with S. H. Phillips, carried on jointly until 1937.

His association with the Department of Highways and Transportation, Province of Saskatchewan dating from that time, he was instrumental in reconaissance and location and construction of highways in Northern Saskatchewan. He worked as chief engineer for several years. The appointment of deputy minister was announced in 1952.

His retirement from the Department in 1954 marked his resumption of a consulting engineering practice, located at Saskatoon.

In 1953 awarded the Queen Elizabeth II Coronation Medal, his outstanding service and prominence in the development of his province was also rewarded. Stewart River, flowing into the Churchill River from Northern Saskatchewan perpetuates in official map and place names his contribution in the field. It is the practice of the Province to give recognition for services in this way.

He joined the Institute as an Associate Member in 1917; transferred to Member in 1940 and to Life Member in 1955.

John Philip Fraser, M.E.I.C., assistant chief engineer, executive, B.C. Electric Railway Company, Vancouver, B.C., died there on June 10, 1957.

Mr. Fraser was born at Hamiota, Man., on June 24, 1893. After a four-year course of study at the University of Manitoba, he graduated in 1914 with the degree, bachelor of electrical engineering. An engineering apprentice with Canadian Westinghouse Company, Hamilton, Ont., for the following three years he served the Canadian Army overseas from 1917 to 1919. Named assistant engineer in charge of the installation of electrical equipment for Westinghouse on his return to Canada, and two years later given complete charge, he was in 1923 promoted to the post of switching equipment designing engineer. He remained with the firm until 1929. During the early thirties employed with the North Western Power Company he was electrical engineer in charge of design, layout and installation of electrical equipment at the Seven Sisters Falls Power House. He also held various positions with the Manitoba Power Commission during that period and was later in 1936 named chief engineer and general superintendent with the organization. Transferring his services to the B.C. Electric Railway Company, Vancouver, in 1940, he became superintendent of generating stations and substations. Three years later he assumed added responsibility as superintendent of generating stations, substations, transmission lines and distribution systems.

The appointment of assistant chief engineer, executive, held at the time of his death, dates to May 1956.

Mr. Fraser joined the Institute as an Associate Member in 1929 and was transferred to Member in 1936.

William Percival Dale, M.E.I.C., retired engineer of Brampton, Ont., died there August 23, 1956.

Mr. Dale was born at Brampton on April 1, 1894. He graduated from the University of Toronto with a B.A.Sc. degree in 1920. His first professional responsibility was that of assistant laboratory engineer with the Hydro Electric Commission of Ontario. In 1922 he became township engineer for the township of Stanford, Welland County, including the residential districts of Niagara Falls, Ont.

In 1916 he enlisted with the Canadian Expeditionary force and went to France with the Canadian Engineers in 1917, serving in France, Belgium and Germany.

Resident in Brampton for many years Mr. Dale was associated with Dale Estates Limited, where he began as plant engineer and purchasing agent in the early nineteen twenties.

Mr. Dale joined the Institute as an Associate Member in 1922 and transferred to Member in 1940. He attained Life Membership on January 1, 1957.

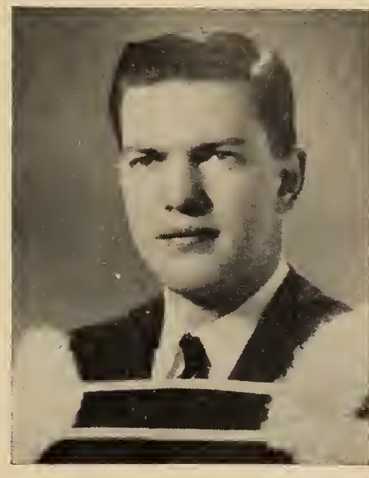
James Breakey, M.E.I.C., engineer with Imperial Oil Limited, Leaside, Ont., died on August 18, 1957 at Toronto.

Born at Sheffield, Eng., on September 19, 1901, and educated at Sheffield University he obtained an associateship in engineering in 1921. He also qualified as a marine engineer. Associated with a Sheffield foundry and engineering company and with the Metropolitan Vickers Electrical Company Limited, Manchester as a part of his training, he was finally in 1925 appointed an engineering assistant with the Vickers organization at Manchester. Two years later he signed on with A. Holt and Company, Liverpool, owners of the Blue Funnel Line, as a sea-going engineer. Resident in Canada by 1929 he worked as a draftsman in the industrial drawing office of Canadian Vickers Limited, Montreal.

He became associate editor for MacLean Publishing Company, Technical Publications, Toronto, in 1931. Within the next few years he was associated with the publication, "Modern Power and Engineering".

Since 1945 employed with the Imperial Oil Limited at Timmins, Ont., St. John's, Nfld., and Toronto, he has served as manager of industrial sales Newfoundland, and as lubrication sales engineer, Toronto.

Mr. Breakey served on the executive of the St. John's Branch of the Institute.



John B. Haire, Jr.E.I.C.

He joined the Institute as a Junior Member in 1931; transferred to Associate Member in 1935; to Member in 1940.

Harry Joseph McCann, M.E.I.C., sales manager for the firm of William Stairs and Son and Morrow Limited, Cape Breton, died August 24, 1957 the result of a motor accident near Halifax, N.S.

Born in the maritimes at Sydney, N.S., on April 8, 1908, educated at St. Francis Xavier University and Marquette University, Wisconsin, he graduated with a B.Sc. degree in electrical engineering in 1933.

He was an assistant electrical engineer with the Dominion Steel and Coal Corporation Limited, Sydney, in 1934 and moved on to become superintendent of Dominion Utilities. Relinquishing the post in 1939 he became manager of the firm with which he was associated at the time of his death. He was also a director of the firm of C. P. Moore Limited, Sydney.

Mr. McCann was chairman of the Cape Breton Branch of the Institute in 1948.

He joined the Institute in 1944 as a Member.

James Metcalf Bennett, M.E.I.C., of the Canadian Blower and Forge Company Limited, Toronto, died on July 1, 1957, at Campbellford, Ontario.

Born at Brockville, Ont., on February 8, 1923, Mr. Bennett moved to Campbellford at an early age. Receiving his early schooling there he went on to study engineering at Queen's University, Kingston in 1941. A graduate five years later he had attained the degree of B.Sc. in mechanical engineering.

Associated with the Canadian Blower and Forge Company Limited since his graduation in 1945 Mr. Bennett served as a sales engineer for some time. Mr. Bennett joined the Institute as a Student Member in 1944, was admitted to Junior Membership in 1947. He became a Member in 1954.

Gordon Albert Christian Eby, Jr.E.I.C., chief engineer of the reinforced plastics division of Brunswick-Balke-Collender Company of Canada Limited, at Toronto died on July 25, 1957, at Rexdale, Ontario.

Mr. Eby was born at Kitchener, Ont., on December 28, 1923. Mr. Eby completed his schooling in that city and then embarked on a wartime career with the R.C.A.F. overseas. Awarded the D.F.C. for his service he enrolled at McGill University to study engineering in 1945. He received a B.Eng. degree in chemical engineering in 1949.

Shortly after his graduation Mr. Eby accepted a position with the E. B. McGee Company Limited at Port Colborne, Ont. Later he was employed with the Dominion Rubber Company Limited, at Kitchener, Ont., and the De Laval Company Limited at Peterborough.

He joined the Institute as a Student in 1949, and transferred to Junior Membership in 1951.

John Buell Haire, Jr.E.I.C., mechanical engineer, of Montreal, died in a motor accident near Carleton Place, Ont., on September 12, 1957.

John Haire was born at Montreal on November 16, 1933. He studied engineering at McGill University and in 1955 graduated with a B.Eng. degree in mechanical engineering. While a student Mr. Haire gained a variety of engineering experience during the summer recess. This included road surveying with the Province of B.C., and with the firm of McMillan and Bloedel. He also worked with the Dominion Engineering Company, at Montreal, and with the Defense Research Board Dominion of Canada, at Valcartier, Que.

Accepted for an appointment with the Standard Oil Company at Aruba, Netherlands West Indies, on graduation, he remained there until July 1957.

At the time he lost control of his car, Mr. Haire was enroute to register for a course in business administration.

In the interim period before commencing his post-graduate studies Mr. Haire was business manager of the well-known McGill University musical, "My Fur Lady".

Mr. Haire was a member of the Canadian team participating in the International Dinghy races at Bermuda in 1955.

He joined the Institute as a Student Member in 1954, was transferred to Junior in 1957.

Personals

News of the Personal Activities of Members of the Institute

J. Herbert Smith, M.E.I.C., (B.Sc., elec., U. of New Brunswick, 1932), has been elected chief executive officer, of the Canadian General Electric Company Limited. Simultaneously he was elected a director of the company.

Mr. Smith, first Canadian born president since 1925 joined the organization in 1932. After managerial assignments in engineering and sales capacities in Peterborough, Hamilton and Toronto, he was appointed general manager of the wholesale department in 1951.

He was elected a vice - president in 1953. Two years later he was appointed general manager of the appliance department with headquarters in Montreal. Prior to his recent call to new duties at head office, Toronto, he has been acting as general manager of the apparatus department at Peterborough.

In 1953 president of the Association of Professional Engineers of Ontario, he was this year appointed by order-in-council of the lieutenant - governor of Ontario to the governing council of the Association.

Mr. Smith is also a member of the Senate of the University of Toronto representing the engineering profession.

E. V. Buchanan, M.E.I.C., of London, Ont., has been appointed chairman of the Engineering Advisory Council of the University of Western Ontario.

Mr. Buchanan is a former general manager of the Public Utilities Commission of that city and of the London Railway Commission.

He has served the E.I.C. as branch chairman, councillor and vice-president. He was a representative on the Engineers Council for Professional Development. In 1951 he was elected president of the Ontario Association of Professional Engineers.

W. L. Hutchison, M.E.I.C.

Ian F. McRae, M.E.I.C., vice-president of the Canadian General Electric Company and general manager of the company's civilian atomic power department, has been elected a director in the organization.

Mr. McRae has recently been elected to the first vice-presidency of the Canadian Manufacturer's Association.

Jack C. Dale, M.E.I.C., (B.Sc., elec., U. of Alberta, 1932), president and general manager of Canadian Utilities, Limited, has been elected a director of the parent company, International Utilities Corporation.

Mr. Dale, who is an Albertan, joined Canadian Utilities Limited, in 1935, later serving overseas in World War II. Returning to Canadian Utilities he assumed the post of general manager of the electrical power company in 1951, that of president and general manager in April 1956.

Hugh Crombie, M.E.I.C., (B.Sc., mech., McGill U., 1918), vice-president and treasurer of the Dominion Engineering Works, Limited is the newly elected vice-president of the Machinery and Equipment Manufacturers' Association of Canada, following an annual meeting held in Toronto.

J. H. Smith, M.E.I.C.

J. C. Dale, M.E.I.C.

Mr. Crombie served as treasurer for the Association shortly after its formation in 1956.

He is a former president of the Canadian Manufacturers' Association.

F. G. Ferrabee, M.E.I.C., (B.Sc., applied science, McGill U., 1924), president, Canadian Ingersoll-Rand Company Limited, has been named a director of the Machinery and Equipment Manufacturers' Association of Canada.

Less than two years ago MEMAC was formed with a view to promotion of Canadian-built industrial machinery both in Canada and abroad.

Mr. Ferrabee is a past-director of the Canadian Industrial Preparedness Association.

W. L. Hutchison, M.E.I.C., (B.Eng., elec. McGill, 1934) has been appointed vice-president of Moffats Limited, Weston, Ont., after a period of two years' association with the firm.

Mr. Hutchison was director of manufacturing, for Remington Rand, in Great Britain from 1946 to 1955.

G. V. Douglas, M.E.I.C., (B.Sc., M.Sc., mining, McGill, 1920), longtime professor of geology at Dalhousie University has retired from the Carnegie chair. Not content to live in retirement, he has established a consulting geologist's office in Toronto at 16 Duplex Ave., Toronto 7, Ont. Professor Douglas will undertake the examination of areas, prospects, or mines.

PERSONALS

Dr. H. S. Van Patter, M.E.I.C., and J. J. Traill, M.E.I.C., represented Canada at the meeting of Technical Committee 4 of the International Electrotechnical Committee, held at Zurich in October.

This committee is charged with the task of drafting an international test code for hydraulic turbines. Twelve countries were represented at this meeting by over forty delegates and excellent progress was made in the work of the committee. The meeting was characterized by a gratifying spirit of cooperation among those present.

J. H. Ross, M.E.I.C.

Georges E. LaMothe, M.E.I.C., (B.A.Sc., Ecole Polytechnique, 1913) retired from the staff of Price Brothers and Company Limited, Quebec City, after many years service, has taken on new duties. As well as teaching forest operations for the faculty of forestry at Laval University Mr. LaMothe is engaged in consulting engineering in Quebec City.

Paul D. Normandeau, M.E.I.C., (B.A.Sc., civil, Ecole Polytechnique, 1938), was elected president of the Association Professionnelle des Industriels at a convention held in Montreal and Quebec City.

Mr. Normandeau's election marks the first time A.P.I. has chosen as its president an engineer and Institute member.

Alan K. Hay, M.E.I.C., of Ottawa, formerly chief engineer of the Federal District Commission has become general manager.

The Federal District Commission is the nationally representative government organization responsible for the implementation of the long-range Master Plan for the development of the National Capital.

J. H. Ross, M.E.I.C., (B.A.Sc., elec., Toronto, 1939), of Hudson, Que., has been named plant manager of Noranda Copper and Brass Limited, with headquarters at the company's main plant and executive offices at Montreal East. Until his present appointment Mr. Ross has been plant engineer for the company. Under his direction a major expansion of the production facilities has been recently completed.

Harry F. Burns, M.E.I.C., (B.Sc., civil, U. of Manitoba, 1950), of the firm of A. D. Margison and Associates Limited, consulting engineers of Toronto, Ontario, has been named as Associate in charge of the firm's traffic engineering department. With the group two years, his last appointment was that of traffic section head of the firm's municipal department, then engaged jointly, with an American firm, on the design of the Metropolitan Toronto Expressway. Mr. Burns' experience in the field of traffic engineering includes two years with the City of Winnipeg as traffic engineer.

W. S. Leggat, M.E.I.C., (B.A.Sc., mining, U. British Columbia, 1939) formerly assistant to the construction engineer for the St. Lawrence Seaway Authority has joined Raymond International Company Limited. Now located at Vancouver he will serve as construction manager for the firm in Western Canada.

Brigadier H. W. Love, M.E.I.C., (B.Sc., civil, Queen's U., 1936), has in his new posting been named deputy quartermaster general, design and development, at Army headquarters, Ottawa.

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CANADIAN CONSTRUCTION ASSOCIATION

• PERSONALS

He is responsible for the co-ordination and supervision of design of equipment.

Brig. Love had been commander of the North West Highway System in Whitehorse.

He is registered with the Yukon Territory Association as a registered P.Eng., and was one of the original members of the newly formed group.

A. M. Lount, M.E.I.C., (B.A.Sc., civil, U. of Toronto, 1946), who for four years has been a member of the firm of T. O. Lazarides, Lount and Partners, has founded the firm of A. M. Lount and Associates.

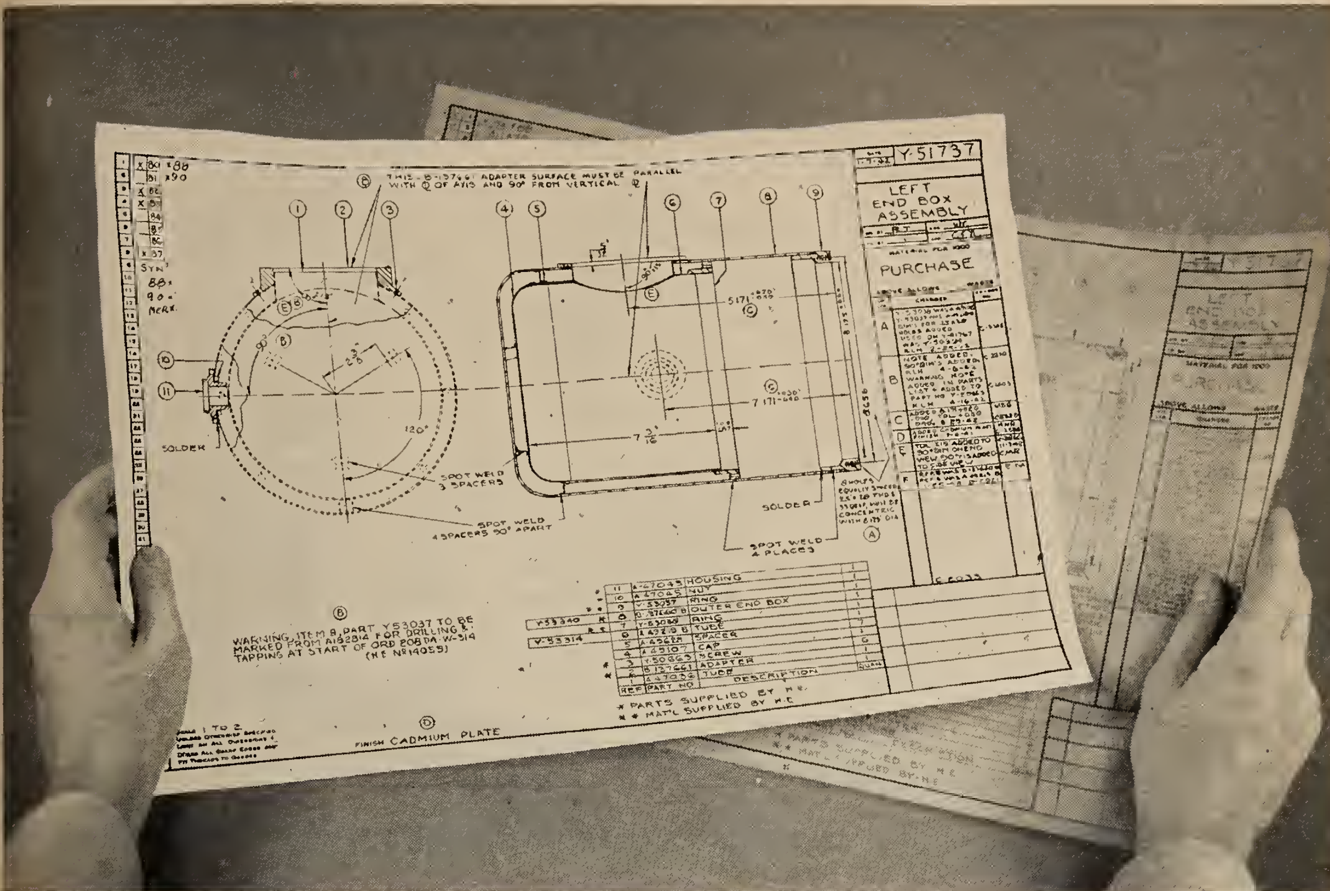
Associated with the Hydro - Electric Power Commission of Ontario from 1946 to 1953 Mr. Lount was for several years

A. M. Lount, M.E.I.C.

in charge of the structural department of the consulting engineering division. He was closely connected with the development of prestressed concrete in Canada. In 1953 the Engineering Institute awarded him the John Galbraith Prize.

Allan Shattuck, M.E.I.C., (B.Sc., U. of Saskatchewan, 1930), for the past ten years a member of the waterworks department of the City of Regina, Sask.,

G. E. Franklin, M.E.I.C.



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and recently design engineer, and has been appointed construction engineer of the Ontario Water Resources Commission, Toronto.

George E. Franklin, M.E.I.C., (B.Sc., civil, U. New Brunswick, 1950) chief engineer, Modern Construction Limited, was elected chairman of the Moncton Branch of the Institute for the 1957-58 term at the annual meeting in May.

Mr. Franklin joined Modern Construction Limited on graduation. His present appointment dates to 1956.

Cdr. (E) V. F. O'Connor, R.C.N., M.E.I.C., (B.Sc., mech., Nova Scotia Technical College, 1934) has transferred from the appointment of senior engineer, H.M.C.S. Magnificent, at Halifax, to engineer overseer of the naval engineering test establishment at Ville La Salle, Que.

Cdr. O'Connor's naval career dates to 1934, shortly after his graduation from the Nova Scotia Technical College. One of his recent postings was that of lieutenant-commander with the Department of National Defence at naval headquarters, Ottawa.

F. A. Benger, M.E.I.C., (B.Sc., mech., Queen's U., 1913), chief of motive power and rolling stock for the Canadian Pacific Railway has retired after having served the company for more than 46 years.

Mr. Benger rose to the post of assistant chief of motive power and rolling stock in 1948. He was assigned the duties of chief of motive power and rolling stock in 1953.

D. J. S. Irvine, M.E.I.C.

A. L. Berry, M.E.I.C., (B.Sc., civil, U. of Alberta, 1947) Westcoast Transmission Company Limited principal pipeline engineer, at Calgary, Alta., has been transferred to senior plans and research engineer for the company at Vancouver.

Active in western engineering circles for some time he has been associated with Northwestern Utilities Limited, Edmonton, and with the Denton Spencer Company Limited, also at Edmonton as a consulting petroleum engineer.

D. J. Irvine, M.E.I.C., (B.Sc., Chem., U. of Saskatchewan, 1941), for five years sales engineer, Exide industrial division, the Electric Storage Battery Company, (Canada) Limited, Central Ontario, has been named resident sales engineer for the company in Manitoba. Offices are at 298 Main Street, Winnipeg.

Leo Vladicka, M.E.I.C., (dipl., civil, Kaunas U., Lithuania, 1944) has a new business address. Associated with the Hudson's Bay Oil and Gas Company Limited, Calgary as senior production engineer for some time he is now employed with the Canadian Pacific Railway, Calgary.

His official position is that of petroleum engineer, mines branch, C.P.R. department of natural resources.

J. J. A. Hall, M.E.I.C., (mech. and production, Higher National Certificate, 1948) is practising engineering in Detroit, Mich., where he is project engineer with the Fruehauf Trailer Company.

Lt. Col. W. B. Akerley, M.E.I.C., (B.Sc., civil, U. New Brunswick, 1932) since 1953 resident engineer for the Canadian Army on the construction of Camp Gagetown, N.B., has retired from the Canadian Army. He has accepted the position of engineer for the development of the new town of Oromocto, N.B.

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PERSONALS

T. F. Scott, M.E.I.C., (B.A.Sc., mech., U. British Columbia, 1946), of the Du-Pont Company of Canada, formerly assistant purchasing agent for equipment at Montreal, has been named purchasing agent, purchasing and traffic department.

Chief supervisor of power in 1952 for the Maitland Works, then under construction, he later took over the post of supervisor of maintenance when the plant went into production.

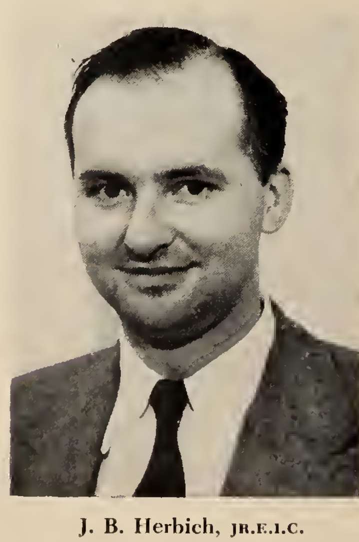
John B. Herbich, M.E.I.C., (B.Sc., civil, Edinburgh U., 1949, M.Sc., U. of Minnesota), has been appointed assistant professor of civil engineering in charge of hydraulic instruction at Lehigh University, Bethlehem, Pa.

Mr. Herbich has enjoyed a variety of professional experience including work with the Netherlands Hydraulic Institute, University of Delft, the Kitimat project, and four and a half years research work at the University of Minnesota, St. Anthony Falls Hydraulic Laboratory.

J. William McNaughton, M.E.I.C., (B.Sc., civil, Queen's U., 1947), has been appointed a general superintendent with E. G. M. Cape and Company (1956) Ltd. He will be in charge of several of the company's construction projects in Ontario. He has served the company on construction in Ontario, Quebec and the Atlantic provinces.

K. A. Oakley, M.E.I.C., (B.A.Sc., civil, U. of Toronto, 1949) has been appointed division engineer, eastern division, producing department, Imperial Oil Limited, London, Ont. Mr. Oakley was previously division civil engineer, Regina division, Regina, Sask., with that firm.

George F. S. Davis, M.E.I.C., (B.Sc., civil, U. of Alberta, 1949), has transferred his engineering services from Calgary to Montreal. Associated with Monogram Pools Limited, in the foothills city, in 1956, he is employed with the Rupert's Land Trading Company, Hudson's Bay Company, in Montreal.



J. B. Herbich, JR.E.I.C.

E. C. Fraser, JR.E.I.C.

C. A. Millar, M.E.I.C., (B.A.Sc., mech., U. British Columbia, 1953) has been promoted to the rank of captain with command of the First Field Engineer Regiment Light Aid Detachment, at Veddar Crossing, B.C. This is a Royal Canadian Electrical and Mechanical Engineers unit attached to the engineer regiment. Regimental headquarters and the L.A.D. are situated with the Royal Canadian School of Military Engineering at Camp Chilliwack, B.C.

E. C. Fraser, JR.E.I.C., (B.Sc., civil, U. of New Brunswick, 1950), has been named eastern sales manager, industrial division with the International Equipment Company Limited. Mr. Fraser's most recent appointment was that of chief engineer following service with the company dating to graduation.

Philip A. Hardwick, JR.E.I.C., (B.Eng., mech. Nova Scotia Technical College, 1950) recently of the Boeing Airplane Company, Seattle, is now employed as a sales engineer with the Bumstead Woolford Company, Seattle, Wash.

Lt. (L) G. A. Kastner JR.E.I.C., (B.Sc., elec., U. of New Brunswick, 1952) of the Department of National Defence, naval service, has gone to Harwell, Berks, Eng., where he is with the Atomic Energy Research Establishment.

J. P. Vilagos, JR.E.I.C., (B.Eng., mech., McGill 1954), has completed his two-year tenure of an Athlone Fellowship in Great Britain. Mr. Vilagos obtained a master of science degree in engineering production and spent a year in British industry.

He returns to his work with the Canadian National Railways department of motive power and car equipment at Montreal.

H. B. Stewart, JR.E.I.C., (B.Sc., mech, U. of Manitoba, 1950), has joined the Toledo Engineering Company Inc., Toledo, Ohio, consulting engineers and contractors for the glass industry. Following graduation Mr. Stewart was employed by Fiberglas Canada Limited as glass furnace supervisor and engineer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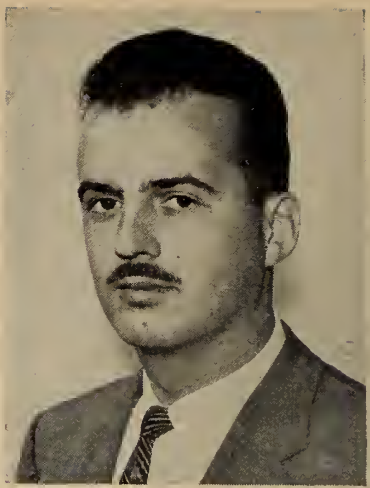
and later as senior design engineer, gaining his initial experience in the glass industry. Prior to joining the Toledo Engineering Company, he was employed by Sproston's Jamaica Ltd. as assistant mechanical superintendent, constructing a chemical plant in Jamaica, B.W.I., for the Aluminum Company of Canada.

Ronald A. F. Latham, JR.E.I.C., (B.A.Sc., mech., U. of Toronto, 1950) has been appointed construction engineer with the Electric Reduction Company of Canada Limited, Toronto in the central engineering department.

Associated with this firm since his graduation Mr. Latham was works engineer at the Buckingham, Quebec works. He was resident engineer on the construction of a new chemical manufacturing works at Vancouver until his recent appointment.

R. A. Brocklebank, JR.E.I.C., (B.A.Sc., civil, U. of Toronto, 1952) is chief engineer, surveys and mapping, with the Photographic Survey Corporation of Toronto, according to a recent announcement. He will be particularly concerned with technical liaison on P.S.C. engineering jobs.

The appointment follows five years experience supervising control surveys on large P.S.C. projects in Peru, Venezuela and the West Indies as well as on mapping and engineering projects throughout Canada.



R. A. Brocklebank, JR.E.I.C.

William L. Booth, JR.E.I.C., (B.A.Sc., civil, U. of Toronto, 1946), has joined the staff of Howard Smith Paper Mills Limited, Cornwall division, Cornwall, Ont. Experienced in the field of pulp and paper he latterly served the Abitibi Power and Paper Company at Iroquois Falls, Ont.

P. E. Coulter, JR.E.I.C., (B.Eng. mech., McGill U., 1956, mech. technology, Ryerson Institute of Technology) has been named technical director of the National Warm Air Heating and Air Conditioning Association of Canada at Toronto.

Mr. Coulter has assumed complete responsibility for the technical programs, problems, and the arrangements and operations of all National Warm Air Heating "Indoor Comfort" Schools.

L. J. Ingolfsrud, JR.E.I.C., (B.Sc., mech., Queen's, 1951; M.Sc., mech., M.I.T., 1952) of the Foundation Company of

P. E. Coulter, JR.E.I.C.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PERSONALS

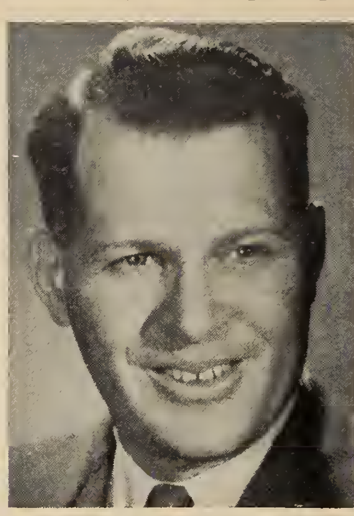
Canada Limited, Chalk River, Ont., where he was resident engineer on the construction of the N.R.U. reactor, recently transferred to the Foundation of Canada Engineering Corporation Limited, Montreal.

Mr. Ingolfsrud is at present in Great Britain where he is following a three-month course at the Harwell Reactor School, United Kingdom Atomic Energy Research Establishment.

J. D. Cape, JR.E.I.C.

Jack D. Cape, JR.E.I.C., (BA.Sc., mech., U. of Toronto, 1950), has been appointed manager of belting and hose sales with B.F. Goodrich Canada Limited, Kitchener, Ont., following a period of work with the firm as sales engineer for belting and hose. He has been employed with B.F. Goodrich since 1950.

M. Edward Bailey, JR.E.I.C., (B.A.Sc., mech., U. of Toronto, 1949), has been promoted by B.F. Goodrich Canada Limited Kitchener, Ont., to special projects assignments with the industrial products division of the firm.



M. E. Bailey, JR.E.I.C

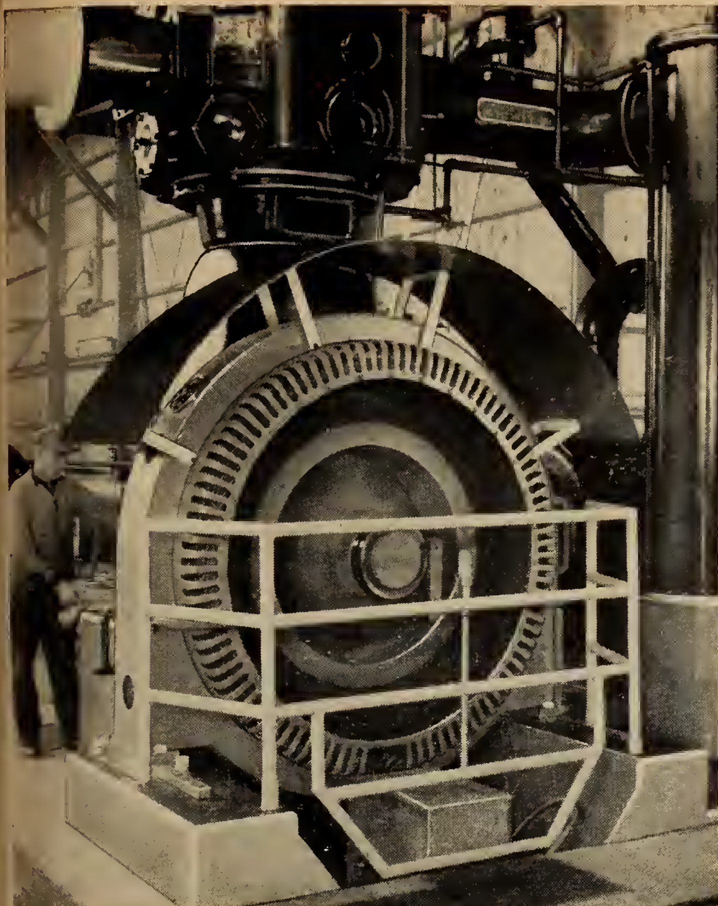
Manager of belting and hose sales since 1953, he joined the firm on receiving his engineering degree.

Douglas R. Wilson, JR.E.I.C., (B.Eng., civil, McGill U., 1951), town engineer at Georgetown, Ont., for some time has taken up work as a design engineer with the Du Pont Company of Canada Limited, Montreal, in the sewer and water division of the organization.

George K. Escott, JR.E.I.C., (B.Sc., civil, Queen's U., 1950), has moved from Toronto to Montreal where he has assumed the vice-presidency of the Mount Royal Paving and Supplies. In 1953 Mr. Escott held office as vice-president and general manager of Associated Quarries and Construction Limited, at Toronto.

P. C. Gunyon, S.E.I.C., a 1956 graduate in mechanical engineering from the University of Toronto has gone to the British West Indies where he is with Alumina Jamaica, Williamsfield P.O.

Albert T. Isaacs, S.E.I.C., (honours, elec., Nova Scotia Technical College, 1957), is attending the University of British Columbia where he is preparing for a master's degree in applied science. Mr. Isaacs holds a National Research Council bursary.



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A General Electric Motor Control Centre is shown being installed in an Ontario uranium processing mill. To slide each unit into its compartment is a simple, quick operation.

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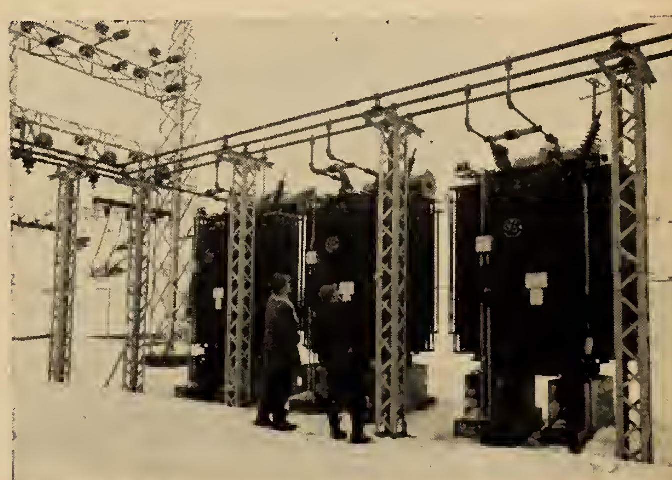

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NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

BELLEVILLE

E. T. HILBIG, JR.E.I.C.,
Secretary-Treasurer

Talk on Hypersonic Flight

The first meeting of the 1957-58 season was held October 7, in the Masonic Temple. Vice-chairman Allan Argue outlined the scheduled program for the fall portion of the season in the absence of J. A. Grant, who was vacationing at the time. Institute Council Member Sillitoe reported on the Banff meeting, dealing specifically with the purpose of the recently established technical sections.

Guest speaker Dr. Gordon Patterson, director of the Institute of Aero-physics at the University of Toronto in addressing the meeting on "Problems of Hypersonic Flight", explained that the basic "shock tube" still plays an important role in scientific development work in aeronautics. In the hypersonic wind tunnel the atomic structure of air actually breaks down, this being a basic difference between it and a supersonic tunnel.

With the help of slides, the speaker discussed the various design features involved in developing aircraft and rockets. Of particular interest were slides dealing with the orbits which would result when an artificial satellite was produced by shooting rockets into outer space at various velocities. The latter feature, and the fact that the first man-made satellite had been successfully launched only three days earlier, provoked an interesting discussion period.

Cape Breton: top photo, left, President C. M. Anson presents a gold E.I.C. pin to W. S. Wilson, honouring his attainment of Life Membership in the Institute. Right, Major C. M. Smythe, an invalid confined to his home, was also honoured by the E.I.C. on attaining Life Membership, as President Anson made the presentation. Below: a special dinner meeting and dance held in his honour at the Isle Royal Hotel in Sydney, N.S., marked the president's official visit. Mr. Anson was presented with a specially engraved gavel of local maple and steel from the first ingots made in the new open hearth of Dominion Iron and Steel Limited. Mr. Anson is vice-president and general manager of the company. Making the presentation is M. R. Chappell, M.E.I.C.

CALGARY

FRED L. PERRY, M.E.I.C.,
Publicity Chairman

Prime Ribs and Beans

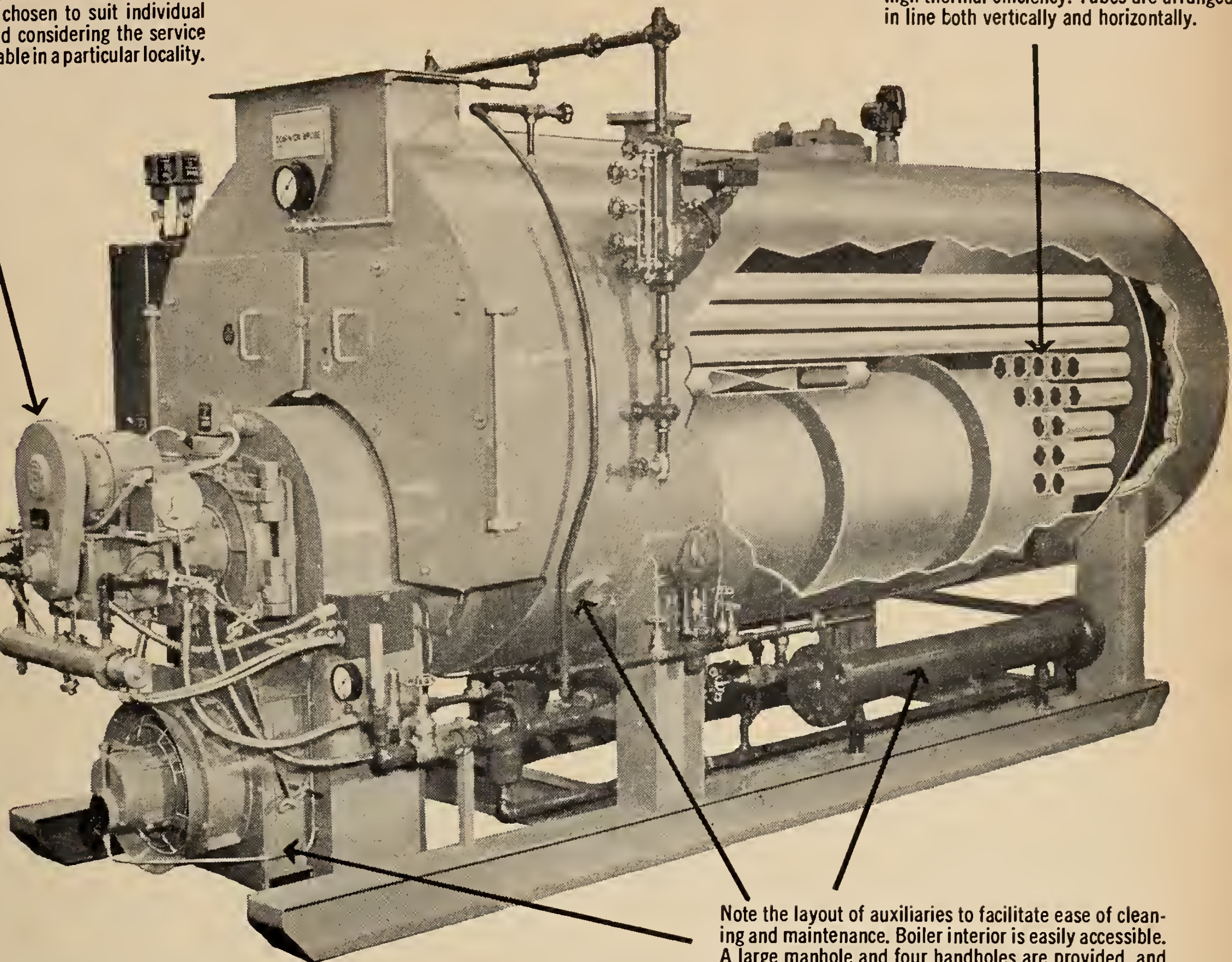
The Second Annual E.I.C. Barbecue, held September 11 at Colpitt's Ranch, attracted 240 members and guests who turned out to enjoy prime ribs and beans around two mammoth campfires.

P.D. Program

The A.C.E. — Professional Development Program began the 1957 season, September 24, in the Southern Alberta Jubilee Auditorium. A series of fifteen programs covering six P.D. subjects has been arranged under the sponsorship of the Institute in co-operation with the Canadian Institute of Mining and Metallurgy and the Alberta Society of Petroleum Geologists. Three hundred engineers and scientists have signed up for the program to date. On the self-development theme, the initial program featured G. Wallace, executive director of the Dale Carnegie Institute, dealing with the subject, "What Makes a Leader." Group dynamics was used effectively to promote group participation under the chairmanship of R. S. White.

First General Meeting

The first general meeting of the 1957-58 season was held October 3 at the Palliser Hotel. Feature speaker, C. K. Fraser, manager of the advanced engi-



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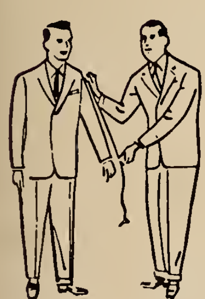

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neering laboratory of the apparatus department, Canadian General Electric Company, Peterborough, Ont., was introduced by Ken Broe. The subject, "Applied Research in a Canadian Industry" first of all developed definitions for the various fields of research and advanced engineering. Special reference was made to the application of polyester and epoxy resins in equipment applications. The development of germanium transistors and selenium rectifiers was described. The increasing use of the analog and digital computers as an important new engineering tool for the designer was outlined.

The meeting adjourned at 9:30 p.m. for the purpose of visiting a Remington-Rand Univac demonstration. Coffee was served while viewing the simulated operation of the computer equipment in the Palliser Room.

HAMILTON

W. A. H. FILER, JR.E.I.C.,
Secretary-Treasurer

J. R. CURRIE, M.E.I.C.,
Branch News Editor

The meeting to introduce the 1957-58 program of the Hamilton Branch was held September 27th, as a "Get Acquainted Smoker" at the R.C.A. Officers' Mess of the Hamilton Armouries. The program included showing of a film of the 1956 All Star Shrine Football Game, and entertainment by Don Hudson at the piano. Approximately sixty members were present at this opening meeting.

It was announced that the technical section chapter of the Hamilton Branch are sponsoring, in co-operation with International Business Machines, a course on computers, to consist of twelve lectures. The first lecture to be held October 7th at the Westinghouse Auditorium. E. R. Bushfield is technical section chairman of the Hamilton Branch.

EDMONTON

G. HODGE, M.E.I.C.,
Secretary-Treasurer

R. H. GARDENER, M.E.I.C.,
Branch News Reporter

Attendance Tops 100

More than one hundred members turned out for the opening meeting of the winter program, October 2, at the Seven Seas, despite a mercury plunge of from 78 to 32 degrees accompanied by snow, sleet and hail.

After cocktails, dinner and discussion of summer activities, Stan Hampton gave a brief run down of the work that was accomplished during the summer session, then highlighted two events on the

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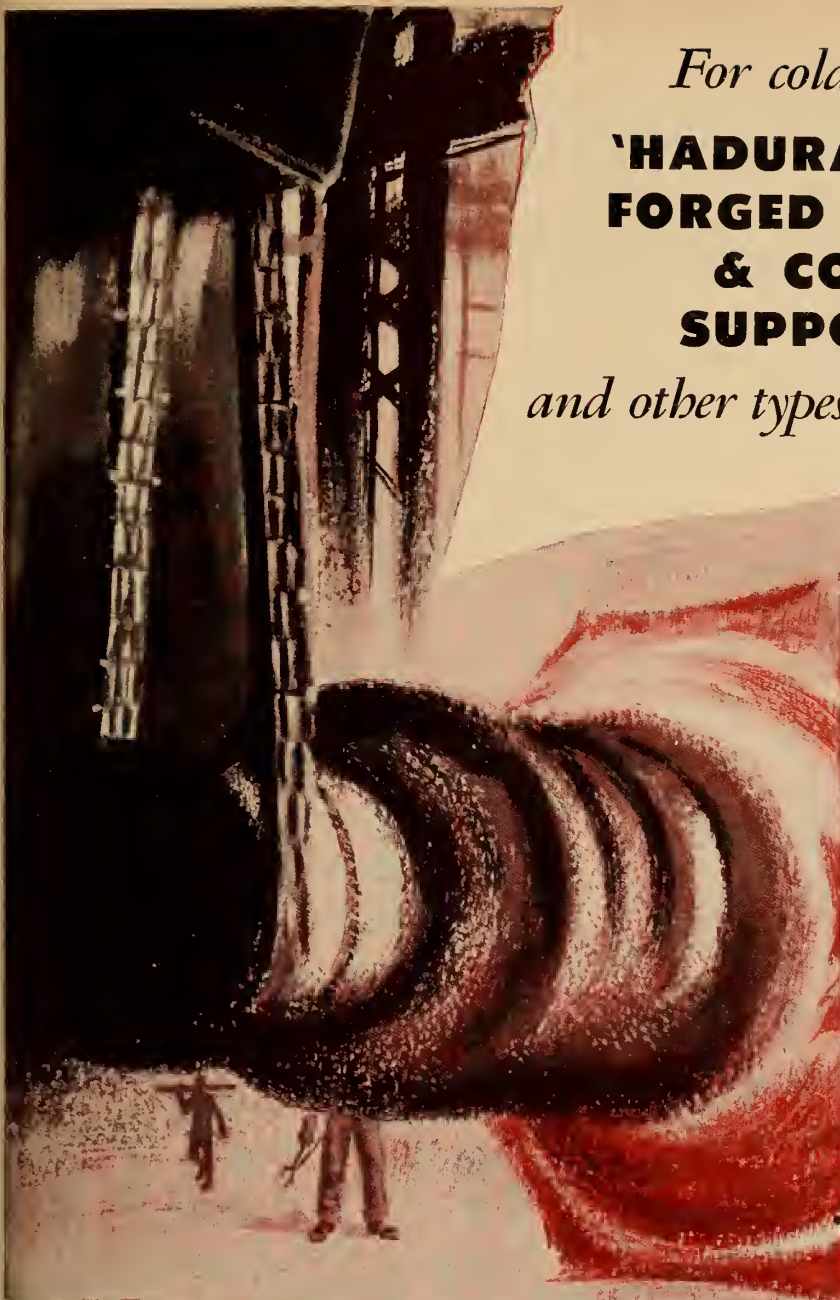

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• BRANCH NEWS

1957-58 program. Main item was a proposed tour through the North Western Pulp and Power plant at Hinton, Alta., which has aroused considerable interest in Alberta. This is due possibly to its many advanced techniques for the handling of pulp, and its size, together with the capital expenditure of several million dollars for its construction. In addition a completely new town has been and is still being built to house the hundreds of people employed by this company.

Second most important event was the annual dinner and banquet scheduled for the end of November.

Field Secretary Present

Among those at the head table was Commodore C. Davy, Western Field Secretary of the Institute who gave a brief run down on his position in Institute affairs. He asked members to contact him directly or through the branch secretary with whatever problems they may wish to discuss.

Telephone Official Speaks

Guest speaker D. Mallet-Paret of the Alberta Government Telephones, a man who has the heavy responsibility of building the microwave system in Alberta that is to connect with the Trans Canada microwave installation, was introduced by Don Edwards. Dr. Mallet-Paret began his talk with a brief outline, accompanied by a film on microwave systems in general and their relation to the telephone installations throughout North America. When this work is complete Alberta telephone subscribers will be able to dial the long distance calls directly via the microwave to sixty-five million subscribers. This would out-mode our present method of dialing the operator to obtain a number, so often accompanied by delay.

Mr. Mallet-Paret described the multiflex systems and by means of excellent colour slides gave an intimate picture of the difficulties to be overcome in the installation of the various towers required throughout Alberta to complete the continental microwave system. The manner in which the sites were surveyed created an interesting point. The comparison was made that in order to establish some of the sites it would have been necessary to survey 25,000 miles by road in three months. Using a helicopter the same route was not only surveyed in 3½ weeks, but the sites were immediately established by means of contour maps and the altimeter which is fitted in the helicopter. Included in the lecture were a number of shots taken from the helicopter, making it possible to appreciate many of the difficulties involved where towers up to 312 feet had to be

erected on prominences of 6,000 feet altitude.

On completion of the present work in 1958, Alberta, which in 1955 had one hundred thousand telephone open miles and sixty-four radio circuits, will possess 170,000 open miles and 140,000 radio circuit miles.

Mr. Mallet-Paret finished his talk by assuring his listeners that the microwave would be officially opened in time for Edmontonians to see directly the Eskimos once again win the Grey Cup, from wherever the scrimmage may be held.

Bruce Allsop thanked the speaker on behalf of the Branch.

MONCTON

V. C. BLACKETT, M.E.I.C.,
Secretary-treasurer

Shediac Cruise

On Saturday, July 27th, branch members and their wives enjoyed a cruise on Shediac Bay, followed by a supper at the Caissie Cape cottage of Mr. and Mrs. G. E. Franklin. The group met at Pt. du Chene, embarking on the cabin cruiser 'Brenda'. A delicious lobster supper was served on the lawn of the Franklin cottage.

The President's Visit

The branch was honoured by a visit from President C. M. Anson and Mrs. Anson on September 24th. Dr. L. Austin Wright, general secretary, and Dr. H. W. L. Doane, vice-president for the Maritime Provinces, accompanied the president.

Shortly after their arrival, Mr. Anson and Dr. Wright visited the City Hall. Introduced to Mayor M. M. Baig, they were invited to sign the guest book of the City of Moncton.

Later in the afternoon, the Headquarters officials met with the branch executive for a round table discussion of matters affecting the Branch and the Institute.

Another feature of the afternoon was the tea held in honour of Mrs. Anson by the Engineers' Wives Association of Moncton Branch, at the home of the president of the Association, Mrs. M. F. K. Leighton. Mrs. V. C. Blackett presided over the tea cups and Mrs. G. E. Franklin served. The guest of honour was presented with a gift on behalf of the Association.

Main event of the presidential visit was the evening dinner meeting which attracted sixty-seven persons.

Mayor M. M. Baig extended a civic welcome to Mr. Anson and others in his party and praised the Institute for the very fine work it is doing for the engineering profession and for Canada.

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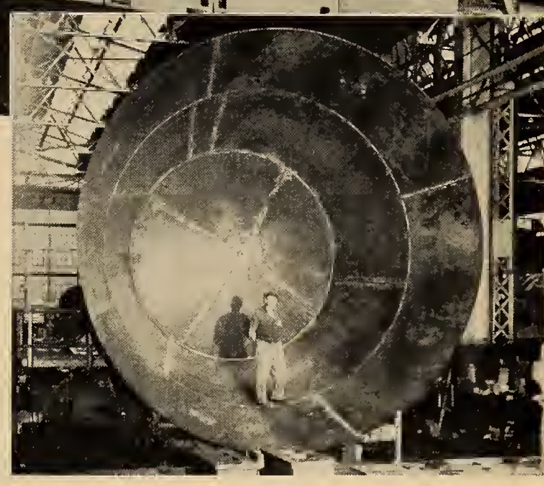

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BRANCH NEWS

The Engineer and Labour

Mr. Anson addressed the meeting on the subject "The Engineer and Labour" and declared that he firmly believed that we shall see the day when the division of the spoils in industry will be carried out in a standardized manner, and one which will be equitable to all interests involved.

This must inevitably take the form of, first of all, providing for the continuation on a sound basis of the industry concerned; second, the provision for a standard wages payment to all those who have been involved in the work of conversion; third, a fair return on the investment involved, and then a further division of whatever surplus remains among the two partners to industry — the shareholders and the workmen.

Dr. Wright Reviews E.I.C. Progress

After brief remarks by vice-president Dr. H. W. L. Doane, Dr. L. Austin Wright reviewed the progress of the Institute during his twenty years as general secretary.

Wives' Association

First fall meeting of the Engineers' Wives Association, Moncton Branch was held October 4th, at the home of Mrs. G. E. Franklin, Salisbury Road. The president, Mrs. M. F. K. Leighton welcomed forty members to the meeting which took the form of a bridge and social evening, convened by Mrs. R. P. Puddester. Five new members, Mrs. J. W. Demcoe, Mrs. E. H. Gilliatt, Mrs. D. A. Slack, Mrs. J. W. Thompson and Mrs. J. Stannix, were introduced by the president and welcomed to the Association. Bridge prizes were won by Mrs. H. J. Crudge, Mrs. T. H. Dickson, Mrs. J. R. Freeman and Mrs. A. W. Purdy. At the close of the evening, refreshments were served.

MONTREAL

G. M. BOISSONNEAULT, JR.E.I.C.,
Secretary-treasurer

With the coming of fall, the Montreal Branch once more swings into high gear with many technical papers planned and top-grade speakers engaged. In addition, the social side of the engineer's life has not been neglected. We sincerely hope there is something planned for everyone's taste.

October Annual General Meeting

This year the Fall General Meeting was held on October 2. In the business part of the meeting, two members were elected to the Branch nominating committee. To replace R. J. Kane, who resigned his position, Professor J. Laurence of Ecole Polytechnique was elected for a period of two years. Replacing J. Budden, retiring member of the committee, T. N. Davidson was elected for a period of three years. The new committee is now composed of the following: Elected: G. N. Martin, J. Laurence, T. N. Davidson.

Appointed: — L. Roy, chairman, Montreal Branch; and G. Boissonneault, secretary-treasurer.

The committee's job is to see that at least one person is nominated for the positions of chairman, vice-chairman and three committeemen of the Montreal Branch for 1958.

Proposed Division

At the Annual Convention in Banff this year members of the executives of the various E.I.C. Branches in the province of Quebec began discussing problems unique to this province. Over several post-breakfast gatherings there arose the decision to study the advisability of

• BRANCH NEWS

forming a Quebec Provincial Division of the E.I.C. The matter was brought before Council, who in turn set up a special committee under G. M. Dick, vice-president, Quebec Province, to pursue the question further. The special committee, composed of representatives of all Quebec Branches, has reported favourably on the question. Their recommendations to Council were accepted and it now remains to place the proposal before all members of the E.I.C. resident in Quebec by means of a letter ballot.

Moncton: President Anson and party in the City Engineer's Office, Moncton, looking over one of the department's maps of the city. Left to right are: G. E. Franklin, chairman of the Moncton Branch; Dr. L. Austin Wright, general secretary; V. C. Blackett, secretary-treasurer, Moncton Branch; Dr. H. W. L. Doane, maritime vice-president; President C. M. Anson, W. M. Steeves, acting city engineer, Moncton.

The purposes of the proposed Quebec Provincial Division are:—

(a) To discuss matters pertaining to Provincial affairs concerning E.I.C. activities in Quebec Province and make recommendations on them to E.I.C. Council.

(b) To promote enlargement of E.I.C. activities and interests in Quebec Province.

(c) To endeavour to start more E.I.C. Branches in Quebec Province.

(d) To endeavour to enlarge E.I.C. membership in Quebec Province.

(e) To co-operate with C.P.E.Q. in all matters where E.I.C.-C.P.E.Q. co-operation would further the interests of engineers in the Province.

(f) To assist in developing the program for Confederation by blending the efforts of E.I.C. and C.P.E.Q. at Provincial and Branch level.

(g) To promote the interests and liaison between E.I.C. and the universities in the Province and thus provide valuable assistance to engineering students at a time in their careers when such assistance would be of great benefit.

(h) To co-operate in implementing the policies of Council in relation to other engineering organizations.

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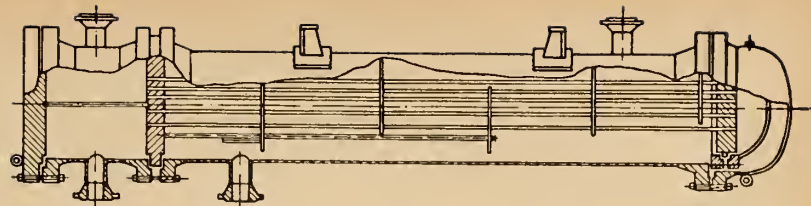

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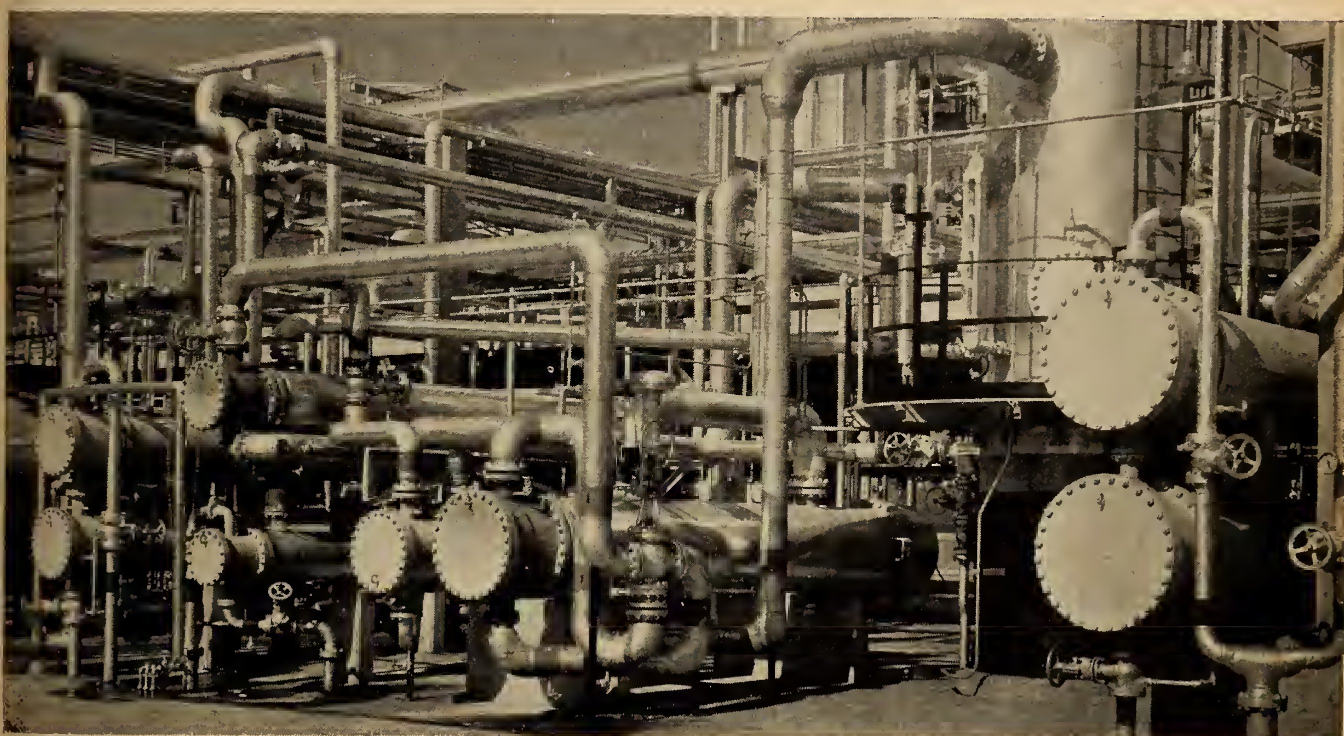

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• BRANCH NEWS

(i) To organize regional meetings with the province.
(j) To undertake any other activities within the scope of a provincial division.

Evening Education

Mr. Gooch's special committee, set up to study the problem of making available evening courses in engineering for residents of Montreal, will soon be contacting all Montreal Branch members. A questionnaire will be sent out asking some very pertinent questions concerning those who work around, above and under engineers.

The object is to form some estimate of the number of men in the area who might be interested in pursuing a course of studies leading to the degree in engineering. Armed with sufficient data, the committee will then be in a position to discuss the problems involved with the educational institutions in this city. Please help your commitee by answering the questionnaire fully and promptly.

Annual Oyster Party

On October 18 the Mont St. Louis gym rang with the clink of bottles and grunts of straining humanity as the Montreal Branch paid their annual homage to that ever-succulent bivalve, his majesty, the oyster. Some of 150 seniors, juniors and students dug in with an abandon known only to those who love oysters. With cheese and crackers and ale to wash it down it was a grand feast, with enough oysters for everyone, including the most ravenous of oyster fans. What a glorious way to die!

Not the least ravenous among the attendants was a visiting fireman from Calgary. Wally Smith of the Calgary Branch's "Pipeline Review" fame was seen getting details for a similar "do" for the Westerners. He also seems to have arranged to relieve some of us poor, unsuspecting Easterners of our ready cash come Grey Cup Day.

Professional Development

The Professional Development Seminar under the chairmanship of Robert Walker has begun. A total of 44 Branch Members have enrolled for this, the Branch's first P.D. course. Well known Montreal businessmen are lending their managerial skills and business experience to coach our young engineers.

Program Committee

The Program Committee have launched their 1957-58 program. This year the program bulletin is being printed on green paper. It is hoped by so doing, that the bulletin won't get lost among the many papers that clutter the desks of our busy engineers.

Another innovation being tried during the fall term is the serving of coffee and cookies at all meetings. This should give those attending a chance to meet and talk with their fellow engineers. Every one is urged to look over the bulletin, pick one or two technical papers in their field and enter into the discussions.

The Immigrant Engineer

The Junior Section of the Montreal Branch has been receiving more pertinent questions from their membership concerning the status of young immigrant engineers within the Province of Quebec. The Junior Section executive is trying to arrange a panel discussion with members of the C.P.E.Q. in hopes of clarifying the confusion that has arisen.

NEWFOUNDLAND

R. L. SMYTH, Jr.E.I.C.,
Secretary-Treasurer

R. P. HUNT, Jr.E.I.C.,
Branch News Reporter

Business Meeting

First meeting of the Newfoundland Branch for the 1957-58 season was held on September 9. A business meeting, an outline of the proposed program for the year was presented by the executive. This was endorsed by the membership.

President's Visit

President C. M. Anson and Mrs. Anson, accompanied by Dr. L. Austin Wright and H. Doane, vice-president of the Eastern Zone arrived in St. John's by air on October 1. Met at Torbay airport by members of the Branch and their wives they were greeted and driven to the Newfoundland Hotel.

Almost immediately Mr. Anson held a press conference for the local press and radio stations. He was also interviewed on a T.V. program.

In the evening Mrs. Anson was a guest at a meeting of the Engineers' Wives Club at the home of Mrs. Grant Jack.

Mr. Anson addressed the engineering students at the Memorial University of Newfoundland the following morning. A courtesy call on His Worship Mayor Mews of St. John's was also made. A luncheon meeting with the executive followed.

The presidential dinner and dance was held at the Old Colony Club that evening, attended by ninety members and guests.

In the absence, due to illness of chairman G. Knight, the duties of were carried out by C. Henry, Branch vice-chairman. After dinner Mr. Anson gave an excellent address on Labour Relations. The talk stressed the importance to the engineer of knowing how to deal with the problems encountered from day to day in dealing with fellow workers.

R. P. Hunt proposed a vote of thanks to the president.

Dr. L. Austin Wright, general secretary of the Institute addressed the gathering on the state of the Institute.

• BRANCH NEWS

V. A. Ainsworth extended a vote of thanks to Dr. Wright.

H. Doane, vice-president of the Eastern Zone expressed his thanks for the welcome accorded the visitors in Newfoundland.

CORNER BROOK

ERIC R. SKANES, JR.E.I.C.,
Secretary

Two Special Speakers

Guest speakers at the September 9 meeting of the Corner Brook Branch were Dr. R. E. Heartz, president of the Shawinigan Engineering Company Limited of Montreal and W. E. Webb, head of the hydraulic department of the British Newfoundland Corporation. Visiting in Corner Brook to discuss the Hamilton Falls power development in Labrador Dr. Heartz said that the project would find a ready market for its power in Quebec and Ontario. The falls, said to have a potential of 4,000,000 horse power and believed largest in the world, are being developed for BRINCO by the Montreal firm.

Dr. Heartz said the two provinces were exhausting their inexpensive power resources at an increasing rate and serving them from Labrador would present no difficulty with modern materials and methods of transmission. He also stated that the Labrador development would compare favourably in cost with any other hydraulic development in the world and would be much less expensive than thermal power houses using coal and other fuels.

Mr. Webb told the Branch that primary work on the project was hampered through lack of information about the area. No accurate rainfall data exists and stations had to be established to obtain figures on the runoff potential.

Mr. Webb added that compiling has progressed rapidly with the aid of aircraft and the new railway line from Sept. Isles, Que. Reasonably accurate information is now available.

Drawings, photographs and movies illustrated the talks.

NIPISSING AND UPPER OTTAWA

R. A. BOOY, JR.E.I.C.,
Secretary-Treasurer

Resume Activities

The first meeting of the current season was held at North Bay, on September 19th, Chairman J. F. Chantler presiding.

At a short business meeting held during the dinner, J. Warburton, chairman of the Papers Committee, noted that the Sudbury Branch, interested in touring the Atomic Energy Commission Plant at Chalk River, had extended an invitation to the Ottawa Branch. Choice of a satisfactory date was to be considered.

Dr. A. R. Clark. Guest speaker. Dr. A. R. Clark of Geophysical Engineering and Surveys' Limited, was introduced by Mr. Warburton. Dr. Clark, prior to joining the staff of Geophysical Engineering and Surveys Limited as chief geophysicist and director of research, in September 1956, spent ten years as associate professor of geophysics at the University of British Columbia. Dr. Clark was accompanied by J. H. Beatson, secretary-treasurer and office manager of the North Bay office.

"Study of Physics of the Earth. Introducing his topic, Dr. Clark first defined geophysics as the "Study of the Physics of the Earth." The particular phase of this with which he was concerned was applied geophysics in the search for ore bodies. In this project they use physical properties of the ore that are different from the surrounding area. There are four main properties: 1) Electrical Conductivity, 2) Magnetic Permeability, 3) Density or Specific Gravity, and 4) Chemical Action. Radiation is also a specific property. Dr. Clark then elaborated on how each one of these properties was utilized and then outlined the main method of investigation of a site.

Following his talk, Dr. Clark extended an initiation to tour the North Bay office, where instruments and displays were available.

Investments Talk

Held at White Oaks Inn, Temiskaming, on October 16, the Branch was privileged to hear J. D. Grant of Wood, Gundy, Brokers at the regular October meeting.

Placing special emphasis on securities, Mr. Grant spoke on "Personal Investments". In opening his talk he mentioned the two main problems on investments —how to invest, and in what to invest.

In connection with the first problem the main possibilities range from the "No-Rick" Bonds which represent a loan for a fixed period, fixed rate of interest, but taxable, through preferred stock, to common stock which has all the risks. The choice of investment in any or all of these types, is mainly a personal matter in which such factors as personal income and responsibilities play a part.

Mr. Grant pointed out that the danger of a market collapse is negligible since the formation of the Bank of Canada, an increase in payments on marginal buying to 50%, and the effect of insurance company investments.

The Gordon Report also forecasts an increase in the gross national product, so that generally any investment is an investment in the future. With a note of caution Mr. Grant concluded his address by mentioning "Speculation" and its pitfalls.

OTTAWA

W. V. MORRIS, M.E.I.C.,
Secretary-Treasurer

A. H. GRAVES, M.E.I.C.,
Publicity Committee

Ottawa Valley Golf Meet

Ninety-seven engineers from the Ottawa Valley teed off in the third annual Ottawa Valley Engineers Golf Tournament held at Arnprior, Ont., on June 21.

Supported by the Corporation, the Ottawa Branch, E.I.C., the A.P.E.O., the Ottawa branches of the C.I.C., A.I.E.E., and C.I.M.M., the golf tournament has been a regular event for the past three years. A play-off was necessary to determine the winner when R. D. Watson, H. D. Tiffin, and J. K. Melville of Arnprior all checked in with 81's. H. J. Riley, representing the Council of the Quebec Corporation presented the trophy to Mr. Watson and announced that next year's tournament would be sponsored by the Quebec Corporation.

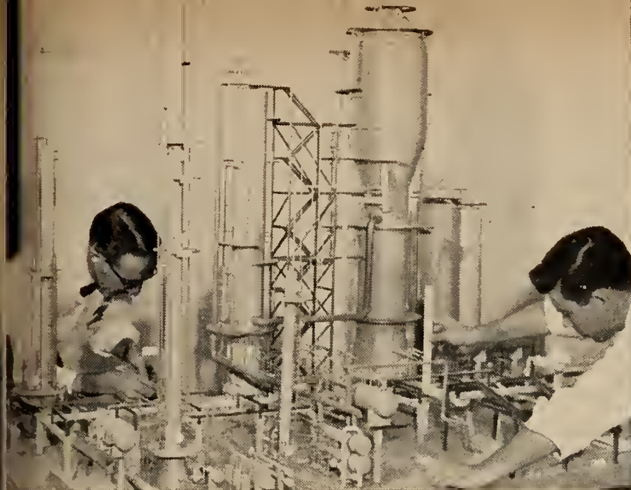
R. F. Legget Speaker

Fifty-seven persons heard R. F. Legget, director of the division of building research, National Research Council, speak at the regular Thursday luncheon meeting of the Branch held at the Chateau Laurier. Subject of the talk was an "Engineer's Notebook on Scandinavia".

Mr. Legget had an opportunity of spending four weeks in Scandinavia during the past summer between attendance at engineering conferences in Stockholm and London. Visiting Sweden, Finland and Norway primarily to study housing and building research also, he saw something of the current construction. He described some of the more important works he visited, including the rebuilding of Hammerfest, one of the most northerly towns in the world.

Mr. Legget was introduced by vice-chairman Hector Chaput, who chaired the meeting, and thanked by K. F. Wrangle, Norwegian engineer employed with the E. B. Eddy Company, Ottawa.

PROJECTION



Scale model of an orthoflow cat cracker, one of several process units.

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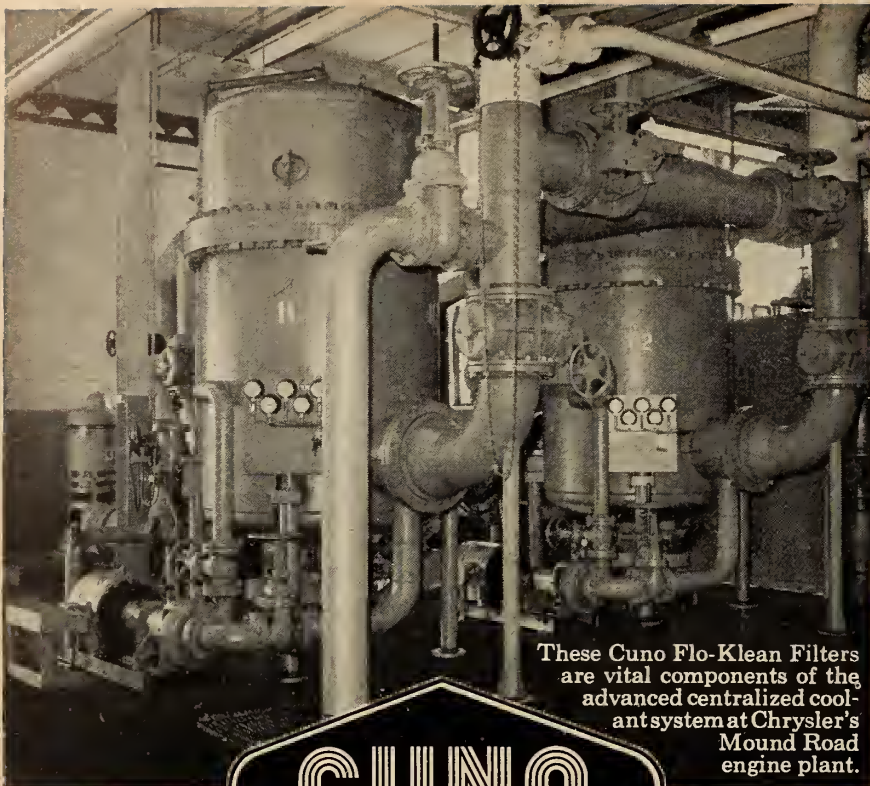


• BRANCH NEWS

P.Eng. Dance

The Professional Engineers' Dance arranged in conjunction with the E.I.C., the C.I.C., the C.I.M.M., the A.I.C.E., and the A.S.M.E., was held on September 26 at the Chateau Laurier. Two hundred and fifty couples attended. The first dance of this type was arranged in 1956.

Talk on Construction

Tullis N. Carter, president of the Canadian Construction Association presented a talk entitled "Construction Industry in Canada", to the Branch. An outline of Mr. Tullis' talk will appear in the December issue of this section.

PRINCE EDWARD ISLAND

Forty Hear President

Prince Edward Island Branch activities, which concluded July 27, with an annual outdoor expedition to Cavendish on the Island's north shore, were resumed September 25. Institute president C. M. Anson and party invoked a turnout of more than forty persons. A good representation for a small Branch, the event was highlighted by the signing of the co-operative agreement between the Institute and the Association of Professional Engineers of Prince Edward Island.

TORONTO

D. S. MOYER, M.E.I.C.,
Secretary-Treasurer

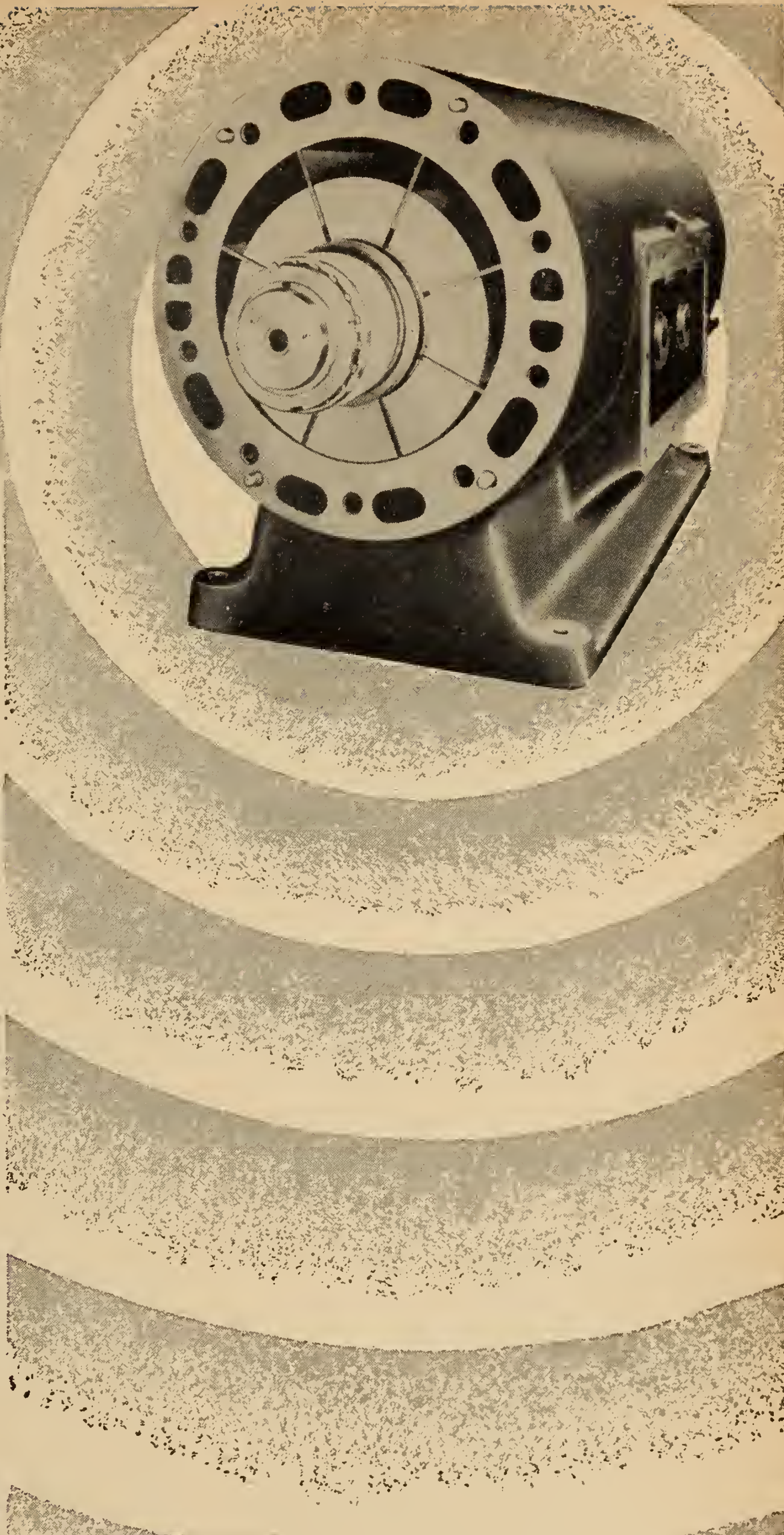
A. C. DAVIDSON
Branch News Reporter

Freshmen's Reception

Freshmen's reception was held in three relays this year. One group laid sod at High Park, in Toronto's West End, under the supervision of the parks department; others were shown around the engineering faculty offices, lecture rooms and laboratories. Another group was taken to Hart House for a tour of the building, followed by refreshments, courtesy of the Toronto Branch. Six hundred freshmen took part in the hospitality provided. Arrangements at registration were made by Mrs. L. Robertson of the Institute Field Office, with the assistance of Norm Seagram, S.E.I.C. who directed the reception part of the program and is to be commended for his contributions to the organization and directing of the affair.

Plant Tour

Toronto Branch activities got under way with a plant tour. The St. Lawrence Cement Company, were hosts to 250 members at their new Clarkson Cement plant near Toronto. A film, giving



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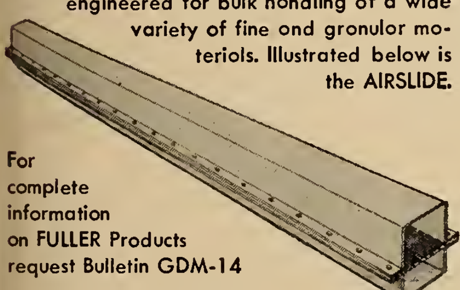

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XA

a clear picture of the various processes of operation to be seen were shown before actual inspection of the plant.

During the tour each process from the raw material unloading dock to the filling of the cement sack before loading onto a transport truck was observed. Detailed literature was dispersed among the members. Thanks go to Lang Farrand for an interesting evening.

Telephone Exchange Visit

The joint committee of the Toronto Branch and the Institution of Electrical Engineers were guests at the Bell Telephone Exchange Building, Adelaide Street West, Toronto recently. Wives and friends included in the invitation were able to enjoy the evening without being technically versed. Tape recorders were available for individual experiments.

Ole Bentzen, project manager, explains the details of the construction of the Deas Island Tunnel to Commodore A. C. M. Davy, M.E.I.C., Western Field Secretary of the Institute, and J. J. Kaller, M.E.I.C., Vancouver Branch executive member, (right).

VANCOUVER

A. D. CRONK, JR.E.I.C.,
Secretary

J. J. KALLER, M.E.I.C.,
Publicity Chairman

Photo Interpretation

Donald Lueder of the Photographic Survey Corporation, an affiliate of the Hunting Technical Exploration Service Ltd., addressed the Branch, September 8, on "The Role of Photo Interpretation in the Work of an Engineer."

Mr. Lueder made clear with numerous examples of aerial photographs the fact that aerial photography is unsurpassed as a means of taking a complete inventory of the photographed areas. Mr. Lueder emphasized that by expert examining of the elements of photo pattern it is possible to evaluate additional

information. Examples are geological maps, the defining of intricate drainage areas, the interpretation of erosion and run-off features, signalling imminent landslides, determining soil and organic moisture content by the evaluation of grey tones of the photos, the locating and assessing of the extent of gravel borrow pits.

According to Mr. Lueder it is possible to obtain information quickly and cut to absolute minimum the sometimes very difficult and costly groundwork involved in an engineering project by means of up-to-date aerial photography interpretation.

VANCOUVER ISLAND

J. A. COWLIN, JR.E.I.C.,
Secretary-Treasurer

Winter Activities

Winter activities began with a meeting held jointly with the Association of Professional Engineers on October 16.

James Sinclair, P.Eng., described construction of the world's largest gas-turbine generating station, built by the B.C. Power Commission at Bare Point, near Chemainus on Vancouver Island. Named the "Georgia Generating Station" after the Strait of Georgia on which it is situated, the plant is of 100,000 h.p. capacity.

A field trip to the station was undertaken later in the month.

As part of the program for the season ahead it is expected that apart from the regular joint meetings there will be a dinner to which the ladies will be invited. It is to be followed by films. Commodore Davy, the western field secretary of the Institute plans to attend and to address the gathering.

Date for the Vancouver Branch annual meeting has been established for some time in December.

WINNIPEG

C. S. LANDON, M.E.I.C.,
Secretary-Treasurer

Electrical Section Meets

On October 3rd, 1957, the Electrical Section of the Winnipeg Branch met at the Canadian Westinghouse Auditorium for the first meeting of the 1957-58 season. The meeting was of a novel nature, consisting of a panel discussion "Specifications of Electrical Apparatus".

Persons taking part in the panel discussion were: R. T. Harland, E. M. Scott, J. W. Walker, P. Shane; with W. H. Dickins acting as moderator. Questions directed to the panel were as follows:

(1) Should a specification be in complete detail or can one rely on the integrity and reputation of the manufacturer?

(2) If you specify "ABC" and a manufacturer quotes "ABC" plus an alternative "XYZ" which you find more attractive — do you go back and give the other bidders a chance to requote? What is your attitude if the manufacturer does not quote ABC but only XYZ?

(3) Have you any views on forms of tender?

(4) Should there be a standard form of progress payment throughout the industry?

(5) Should you state the dollar value of any penalty you apply, for example for transformer losses?

(6) What are your opinions on warranties — should they date from the delivery date or the in service date?

All questions asked provided very lively and informative discussion. Questions were also allowed from the floor and it was evident from the response that this type of meeting is well worth having.

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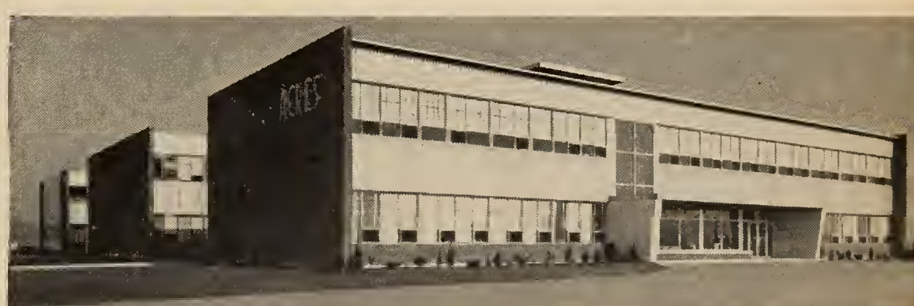

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News of Other Societies

Aeronautical Meeting in Montreal

Montreal's Sheraton - Mount Royal Hotel was headquarters for a joint meeting of the Canadian Aeronautical Institute and the Institute of the Aeronautical Sciences, October 21 and 22.

G. R. McGregor, president of Trans-Canada Air Lines discussing The Economics of Civil Turbine Operation, following the dinner held October 21, declared that Canada, for the first time, is faced with major transformation in the type of power to be used for aircraft. Careful long range planning is necessary.

The number of types of aircraft required to serve the route pattern was another consideration. T.C.A., which takes to the air for distances ranging from 45 miles to more than 3000 has found three types of aircraft, short, medium and long range, to be essential to their operations. The long range type finally selected after two years of study is the DC-8, at a cost of approximately $5 million each.

The margin of airline profit is small; competition is extremely keen; very small amounts of money assume great importance. Selection of aircraft and power plants for them is therefore of the greatest importance. One major mistake in planning may spell bankruptcy.

Mr. McGregor added that the forecast for the future is for higher speeds, especially over the longer distances. The DC-8 will operate at about 550 m.p.h. Flying time, Montreal to London is predicted at six hours.

No great further changes anticipated, it is expected that the 1960's will usher in a period of consolidation.

A total of sixteen papers were presented in the two-day parley. The speakers represented the leading members of the aircraft industry. Papers heard on Monday, October 21, were three on the general subject of Navigation and Air Traffic Control and three on Propulsion, followed by the W. Rupert Turnbull Lecture delivered by G. N. Patterson, director of the Institute of Aerophysics. The address was entitled, "Aerophysical Problems of Flight at Extreme Altitudes and Speeds."

The morning session, October 22, offered three papers on Special Techniques, and an informal discussion on Education and Training. The program for the afternoon presented two sessions, treating of Space Vehicles and Airline Operations.

International Soil Mechanics Conference

The International Society of Soil Mechanics and Foundation Engineering at its fourth conference elected Professor Karl Terzaghi as honorary president. The meeting took place at the Institution of Civil Engineers in Westminster, London, from August 12 to 21.

Professor A. W. Skempton of Imperial College, London, is the successor to Dr. Terzaghi as president. Six vice - presidents were elected, R. F. Legget M.E.I.C. (director, division of building Research Council, being elected as vice-president for North America.

Over forty countries were represented in the attendance of 1,200. One hundred and seventy six papers were presented. Seven papers were offered from Canada. All of the 176 papers are contained in two volumes published before the meeting. The concise reports of the general reporters for the eight sections, into which the subject matter of soil mechanics and foundation engineering was divided, are also included therein.

All discussions will appear in the third volume of the Proceedings to appear later this year.

Made available through the London Publishers, Butterworths, the three volumes, constituting a valuable record of advance in soil mechanics, will sell at approximately $70.00. Inquiries should be addressed to A. Banister, secretary, International Society of Soil Mechanics and Foundation Engineering, c/o Institution of Civil Engineers, Great George Street, Westminster, London, S.W.I.

Conference subject coverage was broad, ranging from an analysis of the gradients of naturally stable slopes in the London clay (around London), to a progress report on the construction of the new large steel sheetpile bulkhead wall in New York harbour, with a promise of a report to the next conference upon the deflection and other measurements now being made upon the bulkhead by P.N.Y.A. engineers. A number of speakers described measurements currently being made of the actual stresses in tunnel linings, and of the strains in rocks exposed in underground excavations. Geotechnical investigations in eastern and central Europe were recorded.

The session devoted to the bearing capacity of piles was of marked interest. It was clearly the sense of the meeting, supported by the printed papers in this section devoted to the bearing capacity of piles, that the proper use of piles is still an art. Calculation of the bearing strength of piles in granular materials is almost on a rational basis but the same cannot be said of friction piles in clay. H. Zweck of Karlsruhe, Germany, presented in this connection, a comparison between the settlements of identical reinforced concrete slabs on the same clay, one pile supported and the other bearing directly on the clay. Settlement was appreciably greater with the piles than without, a result confirmed by other speakers for other clays.

The conference agreed to set up committees to study standard soil mechanics terminology and to attempt to standardize methods of penetration soil testing. Another committee was established with the task of developing an agreed system for classifying soil mechanics literature.

Radio Engineers' Convention

A stimulating glance into the foreseeable future of the electronic world was given to 7,647 technical personnel who attended Institute of Radio Engineers' convention and exposition in Toronto. One hundred and fifteen papers were presented at the three-day meeting held October 17-19.

Included in the exhibits were radio, television and radar equipment with related components in wide variety; communications equipment; control (including tool) mechanisms; computers and counters; measuring equipment; aeronautical and navigational aids; guided missiles, and techniques for tracking and communicating with same; nuclear sup-

• OTHER SOCIETIES

plies and services; cameras, including those for TV aids to medical electronics.

The main session concerned the International Geophysical Year. An excellent picture of Canadian participation in I.G.Y. was given.

How a Canadian - made robot computes the sensations of a man subjected to extreme tests of acceleration and dizziness was described by Dr. W. H. Johnson, of the Defence Research Medical Laboratories, Toronto. The apparatus consists of an assembly of miniature gyroscopes attached to the head. Dr. Johnson said, "we can tell what the subject's equilibrium is, his idea of where he is, and also where he thinks he is going. Findings of the study have facilitated understanding of the experiences of people subjected to different types of motion, as for example in aeroplanes. The whole study project was carried out by Dr. Johnson in collaboration with Dr. W. R. Franks of the Banting Institute, Toronto, and Squadron Leader R. A. Stubbs, R.C.A.F., Institute of Aviation Medicine, Toronto.

Details of a new type of radio pill, indicating the state of stomach muscles to the physician were introduced by J. T. Farrar, Veterans Administration Hospital, New York, and W. J. Bieganski, Radio Corporation of America, Camden, N.J. The new pressure "telemetering" radio pill permits permanent recording of gastro - intestinal mobility without disturbing the patient.

Another paper discussed the study of muscle potential, using six electronic amplifiers. The instrument has been successfully used in the office of Dr. J. V. Basmajian, the speaker, who is the head of the Department of Anatomy, Queen's University.

Psychologists and engineers teamed up in several of the studies to bring scientific aid to business management. Part of it was brought out by W. A. Dimma, assistant to the president of the National Carbon Company. He reviewed the accelerating evolution in this field of management under the heading, "The Changing Concept of the Professional Manager."

Dr. H. Moore, director, Psychological Service Centre, Toronto, discussed, "Selecting Potential Professional Managers," describing the outstanding qualities peculiar to industrial leaders, over and above those needed for normal living.

How science can make keyboard fingers more nimble was explained by Dr. M. Humphries and Dr. J. C. Ogilvie both of the Defence Research Medical Laboratories, Toronto. Experiments to design a keyboard suited to the human hand, thereby achieving greater typing speed with less effort and errors were described. Designed in 1873 the present typewriter keyboard is not designed for the average person, nor for the statistical structure of the English language.

Brainstorming, a spontaneous give-and-take discussion to get ideas on a problem from men in every area of a company, later enlisting them in its solution, was introduced. Claude Watt of the Canadian General Electric Company Limited, said, "In order for these Canadian companies to stay in business, more ingenious methods of manufacture have had to be developed. The brainstorm session has proved a most successful tool in stimulating the creative ideas so necessary where product cost must be reduced, while still retaining the essential quality."

Guest speaker at the banquet Dr. Marcus Long, of the University of Toronto in his address, "Engineers are People," told the 500 guests present that every invention in electronic and allied fields created corresponding responsibilities.

Men misuse their genius, diverting the skill of engineers to wrong ends. He warned, "You cannot sit idly by while men misuse the opportunities you have opened to them. You cannot hide behind the false shield that you are only engineers. Engineers are people."

CEMA Annual Meeting

Holding its thirteenth annual meeting at Niagara Falls, Ont., the Canadian Electrical Manufacturers Association, on October 11 elected Thomas J. Bell, president of Fiberglas Canada Limited, Toronto, president of the 150-member organization. A director in CEMA, 1952, vice-president of the 471-company organization in 1954 he takes over the responsibility from Col. R. D. Harkness, outgoing president.

Topping the billion dollar mark in production for the second consecutive year, the 1956 figure represents an increase of 11 per cent over 1955 totals.

While the position for the future was construed as strong, it was noted that the improvement of the past two years falls short of the peak 16.6 per cent increase recorded for 1953.

Officials warned that while the 3.3 per cent increase in the industry's profit margin over the past two years is considered gratifying it is also among the lowest profit margins in the history of the industry.

In close alliance with the construction industry the electrical manufacturing industry may stand to suffer as a result of shortage of building money a forerunner of further levelling-off process in construction.

Canadians buy more major electrical appliances per household than the peoples of any other country in the world according to a recent sales survey.

The proposal of the United Kingdom that a free trade arrangement be established between Canada and Great Britain raises a host of problems and brings serious attention and comparison of the Canadian and British economies.

Immediate past-president of the Association, Col. R. D. Harkness, stated that "an economy such as ours, on the threshold of wider diversification and industrial expansion cannot move quickly into an orbit where manufacturing is likely to be placed at a disadvantage. Our avowed aim of high level employment, (83,600 in 1956) has been based on the existence of industrial expansion. Consequently any shifts in production and distribution must be examined in terms of the impact on Canadian employment".

Where possible changes in the pattern of trade could bring about expanding employment, then we should be prepared to give them full and favourable consideration," Mr. Harkness said. "Examination of our Canadian trade over the past decade," he added, "shows conclusively that the highest priority must be given to goods and services which will further expand the industrial side of our economy. Authorities on international trade have long agreed that the widest pattern of trade is the most desirable objective. However, world conditions during the past decade have not provided the climate in which multilateral trade could take firm root. It is obvious that currency restrictions, import quotas and bilateral deals of one kind and another have not eased the difficulties."

Calendar

Civil Engineering

The American Society of Civil Engineers held the annual meeting in New York city on October 14-18.

Technical sessions of the convention covered a wide range of subjects including the highway program, power projects in America and other countries, conditions of practice, sanitary engineering, surveying and mapping, engineering mechanics, hydraulics, structural engineering, waterways and harbours, construction, and soil mechanics and foundations.

Louis R. Howson, of Chicago, was elected president for the coming year. Mr. Howson is senior partner of the firm Alvord, Burdick and Howson, consulting engineers. Two vice - presidents and six directors took office with Mr. Howson at the annual meeting.

Four separate items of the program

• OTHER SOCIETIES

were papers as follows: "Unity in the Engineering profession" by Dr. J. W. Barker, president of the Engineers Joint Council; "The St. Lawrence and Niagara Power Projects", by Robert Moses, chairman of the New York State Power Authority; "The Engineer's Biggest Challenge", by Bertram D. Tallamy, Federal Highway Administrator; and "Working for a Firm Employing a Large Number of Engineers", an address by Alfred L. Perlman, president of the New York Central Railroad, to a student chapter conference.

Mechanical Engineering

The American Society of Mechanical Engineers (29 West 39th St., New York 18, N.Y.) offers its largest program ever presented at an annual meeting of the Society on December 1-6, at the New York hotels Statler and McAlpin.

There will be co-operation on the part of the American Rocket Society.

Some of the highlights of the technical program are sessions on air pollution, applied mechanics, aviation, boiler feedwater, consulting engineering, education, temperature effects, fuels, furnace performance, gas turbines, heat transfer, hydraulics, instruments and regulators, lubrication, machine design, maintenance, management, materials handling, metals, nuclear engineering, oil and gas, power, railroad, wood industries, and other subjects:

Testing Materials

The American Society for Testing Materials (1916 Race Street, Philadelphia, Pa.) announces it will hold its annual meeting at the Hotel Statler, Boston, Mass., June 23-27, 1958.

Physics Building

A group of leading scientists gathered in New York on October 21 to dedicate the new building of the American Institute of Physics. The building, at 335 East 45th Street, is headquarters for 20,000 American physicists. The Institute is a federation of five professional societies.

A.W.W.A. Meeting

The annual conference of the American Water Works Association in 1958 will be in Dallas, Texas, April 20 to 25.

The Canadian Section of A.W.W.A. will be meeting in Toronto, Ont., June 1-4, 1958. Secretary of the Section is A. E. Berry, general manager, Ontario Water Resources Commission, Parliament Buildings, Toronto.

Naval Architecture

The annual meeting of the Society of Naval Architects and Marine Engineers (74 Trinity Place, New York, N.Y.) is scheduled for November 13-16, 1957, at New York City.

Metals and Alloys

The Institute of Metals (17 Belgrave Square, Lonodon, S.W. 1) will hold a symposium on "Vacancies and Other Point Defects in Metals and Alloys", under the direction of the Metal Physics Committee. This meeting will be at the Atomic Energy Research Establishment, Harwell, on December 9 and 10, 1957.

Air Traffic Control

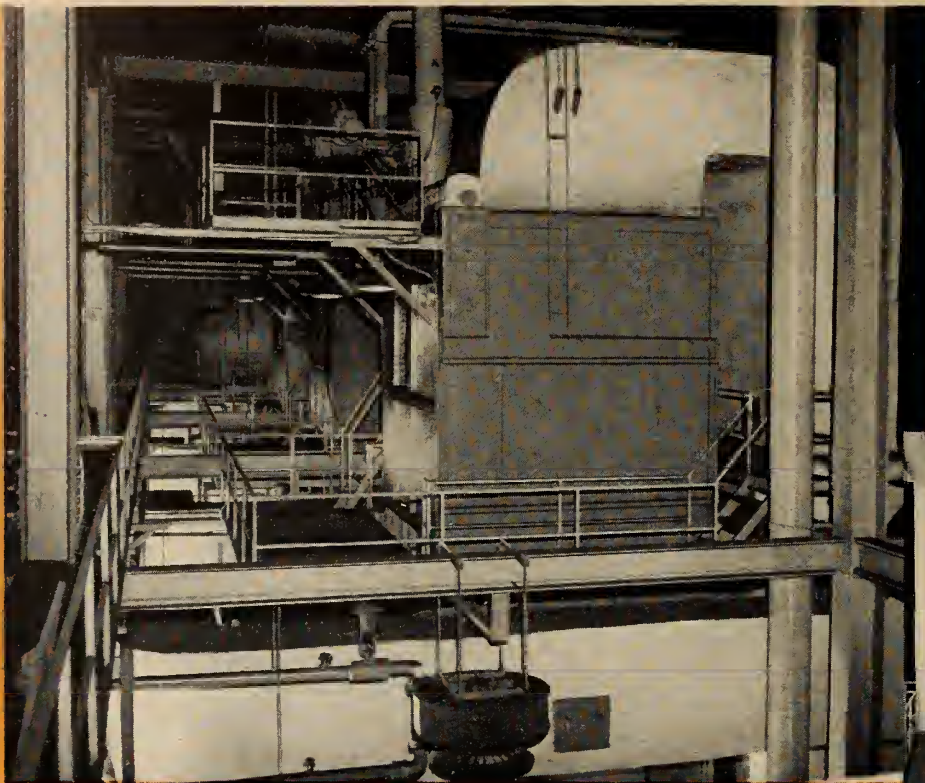
"The Airways Modernization Board: Mission and Methods" will be the subject of an air traffic control symposium sponsored by the Franklin Institute to be held in Philadelphia, December 16, 17, 18, 1957.

For information please write, Air Traffic Symposium, Franklin Institute Laboratories, 20th and Parkway, Philadelphia, 3, Pa.

GAGETOW

HIG

HEATIN



Upper view of C-E, HT boilers in service at Camp Gagetown.

View showing Bowl mill pulverizers whic
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Additions to the Institute Library

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BOOK NOTES

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*ANALYTICAL DESIGN OF LINEAR FEEDBACK CONTROLS

The phrase "analytical design" is identified by the authors as the design of control systems by application of the methods of mathematical analysis to idealized models which represent physical equipment. Starting with the system specifications, the authors describe the input, the disturbances, and the desired response, including a statement of the basis on which the system performance will be judged. Separate chapters discuss the minimization of various errors which represent the performance index. An application of the analytical theory to a practical problem is fully discussed, and a working example of graphical procedure is also presented. (G. C. Newton, Jr., L. A. Gould and J. F. Kaiser, New York, Wiley, 1957. 419 p., $12.00.)

*ATOMIC ENERGY APPLICATIONS WITH REFERENCE TO UNDERDEVELOPED COUNTRIES

The first part of this booklet reviews the uses of nuclear energy. Part II discusses the conditions necessary for using nuclear energy in terms of meeting requirements in cost and resources and in terms of conditions necessary to derive any benefit from a particular use. The last part of the book describes the activities already undertaken to initiate nuclear energy programs in underdeveloped countries. (B. C. Netschert and S. H. Schurr. Baltimore, Johns Hopkins Press., 1957. 129 p., $2.00.)

*BASIC SOIL ENGINEERING

This book provides broad coverage of the fundamentals of soil properties and the engineering behaviour of soils, and explains, from the practical viewpoint, the application of this information to common problems in foundations, earthworks, and highway and airfield engineering. The book is intended to serve as an undergraduate text and as a reference for practising engineers without formal education in the subject. (B. K. Hough. New York, Ronald Press, 1957. 513 p. $8.00.)

*BEHAVIOUR OF METALS AT ELEVATED TEMPERATURES

This volume, based on lectures presented at the Institution of Metallurgists 1956 Refresher Course, will be useful to the metallurgist as well as to the engineer engaged in high temperature work. The effects of high temperatures on engineering properties of metals are covered as well as kinetic heating, high temperature steels, and the effects of high temperatures on air frame structures and guided missiles. (Toronto, British Book Service, 1956. 122 p., $4.25.)

CORROSION AND WEAR HANDBOOK FOR WATER-COOLED REACTORS

The first part of this handbook includes general discussions on the nuclear reactor plant and its relation to conventional power plants, considerations in choosing materials, fundamentals of corrosion and wear, and water technology. The second part provides tabulated data and detailed reference information on methods of testing and on the corrosion and wear resistance of various materials in different environments. The last part deals with special problems such as crevice, stress, and intergranular corrosion, system corrosion deposits, wear, and manufacturing problems. The book is one of a series sponsored by the Naval Reactors Branch of the Atomic Energy Commission. (Edited by D. J. De Paul. Toronto, McGraw-Hill, 1957. 293 p. $6.00.)

*DESIGN OF MACHINES

A clear and concise presentation of basic theory and of practical methods for the design of centrifugal coupling ,thruster brakes, gear reducers, a 30-ton yoke riveter, a manual lift truck. The book is primarily for use in a second course in machine design. (R. T. Hinkle. Englewood Clffs, Prentice Hall, 1957. 188p., $4.00.)

DESIGN OF STEEL STRUCTURES

The design of structural members and their connections, welded, riveted and bolted, is considered in this book, with particular application to steel bridges and industrial and multi-story buildings. The ordinary loads for these structures are considered, and reference is made to the use of aluminum as a structural metal. Earthquake and blast loads are also discussed. The book, one in the McGraw-Hill Civil Engineering Series, closes with an introduction to plastic design. The authors have illustrated their text with many photographs, diagrams, and tables. (E. H. Gaylord and C. N. Gaylord. Toronto, McGraw-Hill, 1957, 540p., $9.60.)

DISPOSAL OF INDUSTRIAL WASTE MATERIALS

The twenty-five papers in this volume were originally presented at a Symposium held at Sheffield University in April 1956. They present the latest British practices and research in dealing with the growing problem of the disposal of many types of industrial wastes in a wide variety of industries. The industries considered include: leather, rubber, textile and paper, paint, ceramic, iron and steel,

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

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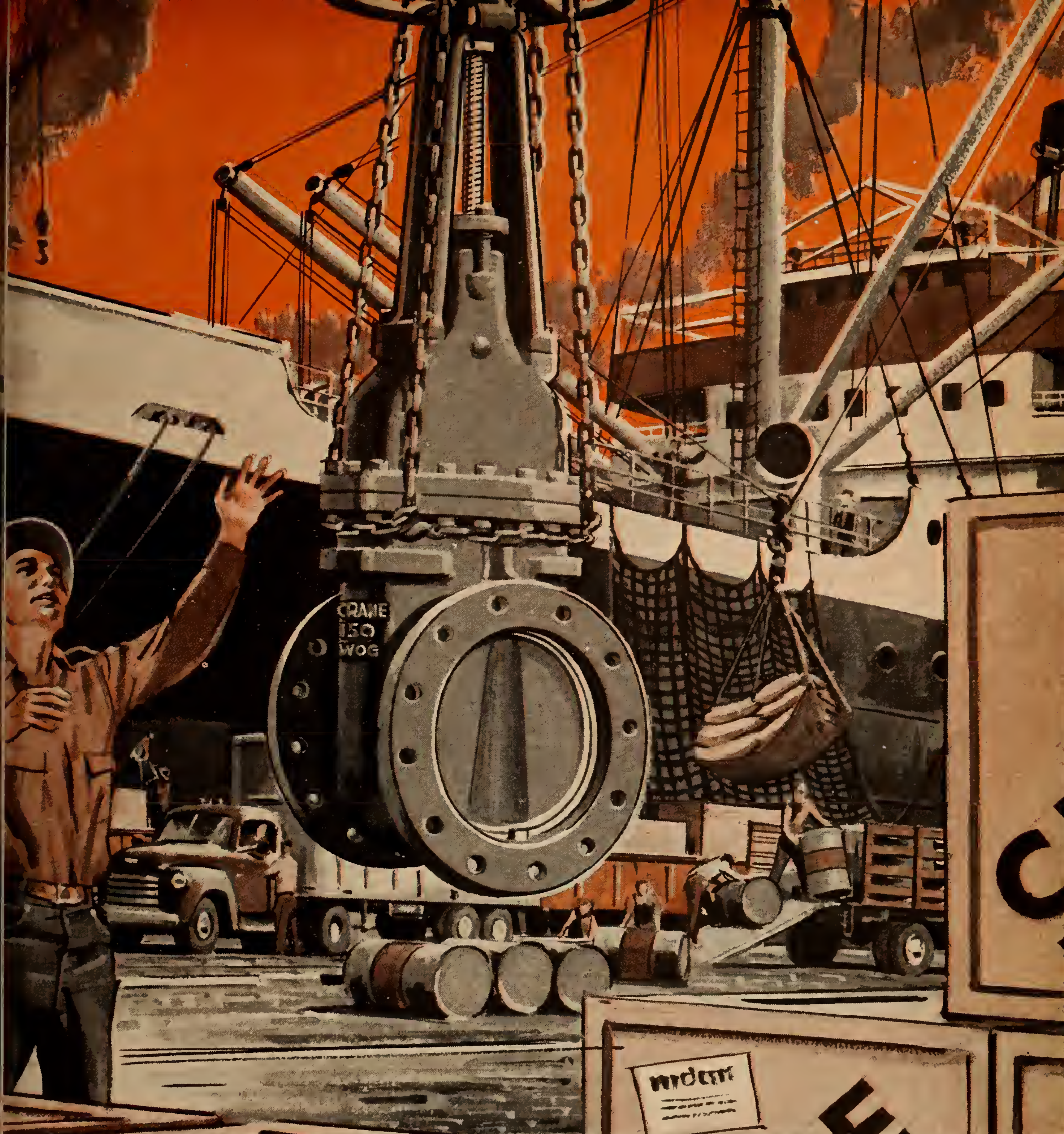
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non-ferrous metals, electroplating, and chemicals, and there are also two papers on radioactive wastes. Most of the papers include bibliographies. (London, Society of Chemical Industry, 1957. 157p.)

*EFFECT OF RESIDUAL ELEMENTS ON THE PROPERTIES OF METALS

The five papers in this book describe the effects of various factors on the structure sensitive properties of metals. The first paper entitled **Fundamental Considerations** discusses the effects of lattice imperfections, solute atoms, and the presence of a second phase. The remaining papers deal with impurities and residual elements in common nonferrous metals, steels, semi-conductors, and the so-called newer metals—titanium, zirconium, molybdenum, and chromium. (E. R. Parker and others. Cleveland, American Society for Metals, 1957. 217p. $4.00.)

*ELEMENTS OF HEAT TRANSFER

The reviser of this book has maintained the emphasis on basic principles of previous editions but has changed the subject matter freely to meet the needs of today's engineering students. Some of the changes are: a new section on equivalent circuits for solving heat transfer problems, revision of the chapter on free convection, a new section on gas radiation, and a new chapter on mass transfer. New references and new problems have also been added. (Max Jakob. Third edition revised by G. A. Hawkins. New York, Wiley, 1957. 317p., $6.75.)

*FUNDAMENTALS OF MECHANICAL DESIGN

This text is an integrated treatment of kinematics, mechanism, dynamics of machinery, and design of machine elements, presenting in one volume the essentials of the sequence of courses usually offered to mechanical engineering students. It is intended primarily as a textbook for electrical, mining, and other engineering students not specializing in mechanical engineering, but it may also used as a refresher for engineers not in close contact with the field of mechanical design. (R. M. Phelan. Toronto, McGraw-Hill, 1957. 526p., $10.50.)

*GLOSSARY OF GEOLOGY AND RELATED SCIENCES

Prepared by a staff of nearly 100 specialists from 25 areas of geology and related sciences, this new glossary contains about 14,000 terms. Many terms commonly used in applied petroleum, mining, and engineering geology are included, as well as those used in theoretical geology and geophysics. Sources of most definitions are cited. (Washington, American Geological Institute, 1957. 325 p., $6.00 (payable in advance.)

MAKING, SHAPING AND TREATING OF STEEL, 7TH ED.

This seventh edition of a work first issued by United States Steel in 1919 is intended for steel users, steel plant employees and trainees, students, librarians and any others wanting a handy compilation of facts relating to the iron and steel industry, both past and present.

The first of the fifty chapters of which this volume is composed presents an historical introduction to the subject, following this the topics covered include material on fuels and combustion, coke, iron ores and mining, the various processes in iron and steel manufacture, and the manufacture of different shapes and products such as rails, wire, plates, tubular products, etc.

Steel corrosion and protection is also discussed, as is heat treatment and different types of steel; carbon; alloy; high-strength low-alloy; stainless steels; and steels for high temperature use. Two final chapters cover mechanical testing and gage numbers.

There are many illustrations, tables, etc., and bibliographies of references for further reading are found at the ends of most chapters. Some idea of the scope of this work can be gathered from the size of the index which is over a hundred pages long.

This is a most valuable book. (New York, United States Steel, 1957. 1048p., $8.70, payable in advance.)

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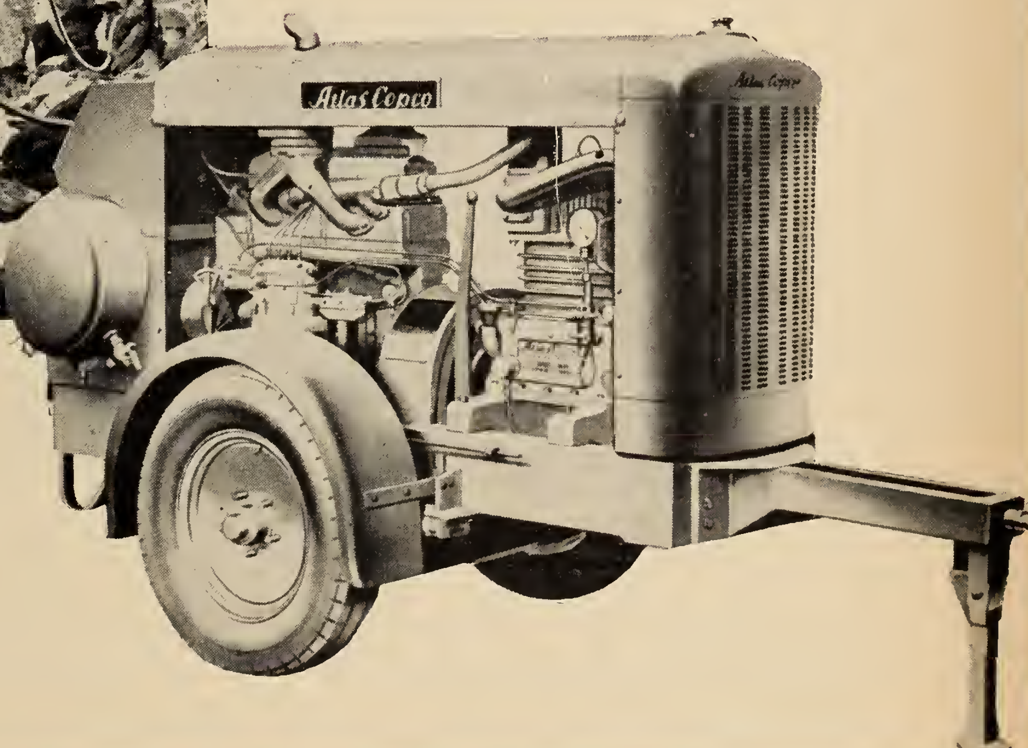

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MASONRY SIMPLIFIED, 2ND ED.

The first volume of this two volume work discusses the tools, materials and practices of masonry in an easily understood form.

The first three chapters cover the cementious materials used in masonry construction: lime, its manufacture, storage and use; the various types of mortar, their properties and uses; concrete, its reinforcement, mixing and placing. There is a useful chapter on blue print reading, and the three following chapters describe the principles of wall building and their relation to construction in concrete masonry, structural clay tile, and brick masonry. A final chapter describes the building of sidewalks, driveways, floors, and steps.

The final section of this first volume is an illustrated dictionary of building terms.

In volume two the principles of masonry construction are applied to actual problems encountered in building. Some of the topics covered include: building forms for concrete; design and construction of footings; foundations and waterproofing; beams, lintels and columns; chimney and fireplaces; walls and partitions; septic tanks. A final chapter is devoted to maintenance and repair.

Both volumes contain a wealth of diagrams, and the books should prove extremely useful not only to those engaged in or entering the building trade, but also to those who do their own masonry work. One of the authors, Gilbert Townsend, is a member of a firm of architects and engineers in Montreal. (J. R. Dalzell and Gilbert Townsend. Chicago, American Technical Society, 1956-57. v.1, 463p., $7.20: v.2, 438p., $7.95.)

*MICROWAVE MEASUREMENTS

This thorough treatment of the basic forms of electrical measurements in the microwave region of the electromagnetic spectrum provides a background for all common measurements as well as for some of the more specialized applications. The principal subjects treated are generation of laboratory signals; detection and measurement of mierowave power; the measurement of impedence, wave length, and frequency; representation and measurement of microwave circuits; and resonant cavity characteristics. The book has been written as a text for graduate students and as a reference for engineers. (E. L. Ginzton. Toronto, McGraw-Hill, 1957. 515p., $14.40.)

THE NEXT HUNDRED YEARS

In 1956 three scientists from the faculty of California Institute of Technology held a series of discussions with the executives of thirty United States industrial corporations in an attempt to estimate man's future needs and the ability of the earth's natural resources to supply them. An attempt was made to forecast the future of industrial civilization, and to draw a picture of what that future will be.

This book records the ideas arising out of the discussions concerning demands for raw material and for technical manpower and how these demands may be met, rates of industrialization; the growth of population, and how its demands for food will be met.

The authors appear to have every confidence in the future of the world, and in their opinion the increasing demand for raw materials, food and brainpower can be met quite adequately by a world at peace. A full-scale nuclear war would however mean the end of industrial civilization for all time, even for the survivors of such a holocaust. As they say "The future of industrial society revolves around the question of whether man can learn to live with man." (Harrison Brown, James Bonner and John Weir. Toronto, Macmillan, 1957. 193p., $4.50.)

THE ORGANIZATION MAN

Who is the organization man? The author, assistant managing editor of Fortune, believes he is the middle-class American who can be found in corporations, in laboratories, in the courts, in foundations, and in the church hierarchies. He is sinking his own personality in that of the organization, and he sets the pattern of American thought and living.

The author pursues his man through his training in school and college to his moulding in The Organization itself. He examines the Organization Man at home in the new suburbia: his social life, his religion and the schools his children attend, where the whole cycle begins again.

You may not agree with everything, or anything, the author writes, but his book is well worth reading, and illustrates very clearly the modern trend in living. (W. H. Whyte, Jr. New York, Simon and Schuster, 1956. 429p., $5.00.)

*PETROLEUM AND ITS PRODUCTS

This is a concise summary of the whole field of petroleum production, covering exploration and drilling, crude oil composition and refining, and the manufacture, properties, and applications of petroleum derivatives. A list of basic references and important petroleum periodicals is appended. (J. H. Van Der Have and C. G. Verver. Toronto, Pitman, 1957. 421p., $10.00.)

*PETROLEUM CARGOES: MEASURING AND SAMPLING

A highly practical treatment of the problem of determining the quantity of petroleum products, from crude oil to high-octane gasoline, contained in oil tankers or barges. The explanatory material and the extensive group of tables cover not only bulk measurements and conversions, but also specific gravity determinations, volume correction coefficients for temperature, and other necessary or useful information. Petrochemicals and coal tar products are similarly treated in appendices. (H. Hyams. Glasgow, Brown, Son and Ferguson, 379p. 50/-.)

*REFRIGERATION AND AIR CONDITIONING, 2ND ED.

Intended for senior and graduate study, this text is designed for a comprehensive course. It is assumed that the reader has studied physics and mathematics, although one chapter contains a review of basic thermodynamics. Descriptive material on equipment follows closely the presentation of theory applicable to such equipment. Specialized advanced topics and applications are placed toward the end of the text. A large amount of graphic and tabular material allows easy reference use by the practicing engineers. (R. C. Jordan and G. B. Priester. Englewood Cliffs, Prentice-Hall, 1956. 555p., $8.00.)

*REGIME BEHAVIOUR OF CANALS AND RIVERS

Constituting a first formal text on the science of "mobile boundary hydraulics", the aim of this book is to develop and apply, to any river or canal capable of self-adjustment, the quantitative laws of the movement of boundary material. Utilizing the observations of irrigation engineers, hydrologists, and geologists, the author presents formulas for various conditions of breadth, depth, slope, and bed load, and demonstrates their use in the type of complex problem presented by any shifting channel. Some discussion of the construction, interpretation of data, and usefulness of river models is included. The author, a member of the Engineering Institute of Canada, is a Professor of civil engineering at the University of Alberta, and was formerly Director of irrigation research in the Punjab. (T. Blench. Toronto, Butterworth, 1957. 138p., 30/-.)

THE SCIENCE OF ENGINEERING MATERIALS

Based on a conference held at the Carnegie Institute of Technology in 1954, the papers reprinted in this volume attempt to show why materials behave as they do by applying the principles of solid state physics to the explanation of the properties of materials.

The first part of the book deals with the structure of matter: the applications of solid-state science in engineering, and the structure of atoms. Qualitative explanations are given of metals, alloys, semi-conductors and non-crystalline materials such as cements, polymers and glass. There are also chapters on surface phenomena and magnetism and magnetic properties. (Ed. by J. E. Goldman. New York, Wiley, 1957. 528p., $12.00.)

*SOLAR RADIATION IN AIR CONDITIONING

A handbook for engineers planning air conditioning for buildings in the tropics.

• LIBRARY NOTES

Information is given on the special difficulties involved in making calculations because of sun load in these regions. The discrepancies among the various methods is discussed. The methods are related to specifications of the plant and particulars of the building, and there is material to assist in making calculations direct from meteorological data should this be necessary. There are sections showing calculations and actual performance data. (I. S. Groundwater. London, Crosby Lockwood, 1957. 125p., 25/-.)

*STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS, 9TH ED.

This standard reference tool has been revised and broadened in scope to cover the many innovations and developments in the electrical field in the last decade. Experts in each area have reviewed the twenty-six major sections of the book thoroughly and provided new or expanded data on nuclear power, dielectrics, transistors, telemetering, electrical measurement for automation, etc. Information on new synthetic materials and recent metals has also been included as well as electric conductor tabes based on latest ASTM standards, and new international electrical units and values. (Ed. by A. R. Knowlton. Toronto, McGraw-Hill, 1957. 2230p., $19.50.)

*STRUCTURAL DESIGN IN METALS, 2ND ED.

The new edition of this text for a first course in design emphasizes basic training in the application of the statistics of simple structures and the strength of materials to details of design. In the revision, additions have been made to chapters on rigid frame design and design with light gage metal, and recognition has been given to the use of other metals besides steel. (C. D. Williams and E. C. Harris. New York, Ronald Press, 1957. 655p., $8.00.)

*SYMPOSIUM ON CORROSION FUNDAMENTALS

Fifteen lectures presented at a conference at the University of Tennessee in 1955 dealing with coatings for corrosion protection, high temperature corrosion, problems in steam power and industrial boiler plants, cathodic protection, plastics and plastic liners for protection, etc. The aim of the symposium was to consider fundamental factors underlying the causes and prevention of corrosion in a way which would contribute to industrial corrosion control practice. (Edited by Anton de S. Brasunas and E. E. Stansbury. Knoxville, University of Tennessee Press, 1956. 255 p., $5.00.)

*SYNTHESIS OF PASSIVE NETWORKS

Assuming a good understanding of essential mathematics and basic circuit analysis, the author presents the fundamental theory of the subject matter, general methods of synthesis, and sufficient examples to clarify the presentation. The detailed treatment covers both the approximation problem and the realization techniques. As an essential tool in a broad field of engineering activity, the subject is sufficiently developed to prepare the reader for independent work. A subsequent volume will cover "special problems in network synthesis." (E. A. Guillemin. New York, Wiley, 1957. 741p., $15.00.)

*A TREATISE ON PHOTOELASTICITY, 2ND ED.

Publication of this volume makes available again a standard authority that has been out of print for several years. The present edition is substantially the same as the first (1931), except for correction of misprints and minor errors, and for changes made necessary by the omission of the color plates. The latter have been replaced by half-tone prints where important. Significant developments since 1931 are reviewed in an introduction and a bibliography of important recent publications has been added. (E. G. Coker and L. N. G. Filon. Revised by H. T. Jessop. Toronto, Macmillan, 1957. 720p., $11.25.)

URBAN LAND USE PLANNING

A scholarly study of the theory and techniques for planning the renewal and development of cities with populations of from 100 to 500 thousand, but also useful for any city faced with a planning problem, this volume is divided into three parts.

The first of these presents the theory of the determinants of land development — economic, social and public interest determinants. The second part describes the methods used in assessing the exiting situation; employment and population studies, the urban economy, urban land use and transportation. The final section is devoted to planning a rational use of the land available for industry, housing, recreation etc. paying attention to the requirements of health, safety, convenience, economy, and future development. (By F. S. Chapin, Jr. New York, Harper, 1957. 397p., $8.00.)

*WINDOWS AND GLASS IN THE EXTERIOR OF BUILDINGS

Recent advances in the various phases of window science and technology are detailed in this book which covers problems in daylighting as well as heat transfer through fenestration and its control. Chapters on properties of glass, windows in modern architecture and various frame types are included under product engineering, and the book concludes with material on design applications in residential and office buildings, commercial installations, and schools. (Washington National Research Council, Building Research Institute. 176p., $5.00.)

WORK SAMPLING, 2ND ED.

Active in the field of industrial engineering for many years, the author is currently serving as consultant for the establishment of a School of Industrial Administration in Madrid. In this book he presents an analysis of the technique of work sampling, and shows how it can be applied in both offices and factories.

Much of the material and case histories have been contributed by those active in the field, and many papers on the subject are listed in the bibliography. The author reports on the research which has been done, including that by Tippett who was a pioneer in the field. (By R. M. Barnes. New York, Wiley, 1957. 283p., $7.95.)

TECHNICAL BULLETINS AND PAMPHLETS RECEIVED

Air Conditioning

Distribution of air within a room for year-round air conditioning — part 2, by H. E. Straub and M. M. Chen. (Illinois University. Eng. Exp. Sta. Bull. no 442)

Air Travel

Air travel forecasting; market analysis method domestic air passenger market 1956-1957 (Eno Foundation for Highway Traffic Control)

Aviation

The Times survey of British aviation. London, 1957.

The Financial Times survey of air transport. London, 1957.

Concrete

Concrete deterioration of a foundation by G. M. Idorn. (Acta polytechnica no. 221) Cophenhagen, 1957.

The principles of the "N" and "N-free" methods of calculating reinforced concrete sections subject to bending, by A. Mehmel. (Canada. N.R.C. Technical publication no. TT-664) Ottawa, 1957.

Copper

Strength of brazed joints in copper and copper alloys by W. M. Munse and others (Illinois. University. Eng. Exp. Sta. Reprint no. 57)

Technical survey, OFHC brand copper; high conductivity, oxygen free (American Metal Co. Ltd.)

Cylindrical Shells

Creep buckling of cylindrical shells by E. Sundstrom (Royal Institute of Technology, Stockholm, Transactions, no. 115, 1957)

Snap-through and post-buckling behavior of cylindrical shells under the action of external pressure by H. L. Langhaar and A. P. Boresi (Illinois. University. Eng. Exp. Sta. Bull. no. 443).

Electrical Engineering

Electrical Research Association: Technical Reports. L/T347 — Polarizability of dilute solid solution of dipolar molecules at low temperature by J. A. Sussman. L/T 359 — Models of materials with loss per cycle nearly independent of frequency by H. Pelzer. M/T122 — Radio interference from high voltage distribution systems by S. F. Pearce. Q/T143 — Electromagnetic forces in transformers with multi-layer windings by M. Waters. V/T120 — A stable decade amplifier for the frequency range 10 c/s to 1 Mc/s by D. C. G. Smith.

The acoustical design of enclosures for power transformers, by T. D. Northwood and others. (Canada. N.R.C. Div. of Building Research. Paper no. 31) Ottawa, 1957.

Der kombinierte einsatz basischer und saurer elektroden in der schweibtechnik, by G. Gerber. (CZ no. 21, May, 1957) Zurich, 1957.

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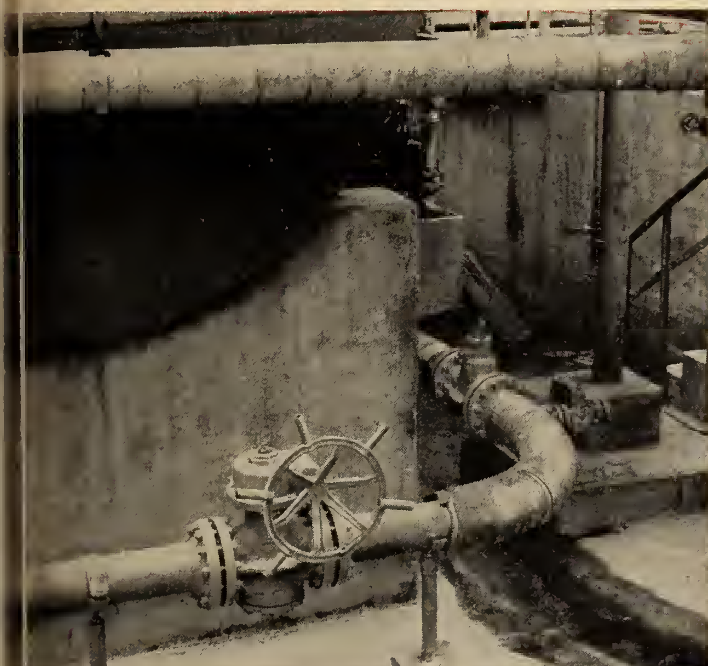

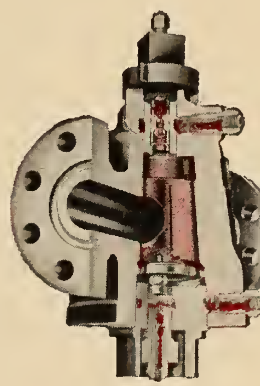

H. F. ACID

HOT ASPHALT

Power Plan for Yukon River Waters

(Continued from Page 1646)

Canada indicates that in the foreseeable future rapid development of economic sites will be necessary to meet the increasing demand. This demand will stem from many sources. There is the well-defined increasing use of electricity for general, municipal and domestic purposes, and for secondary industries, due to a rising standard of living. There is the rapidly growing power demand for the processing of strategic minerals, for chemicals, plastics, construction materials and for high-grade and costly alloys. These primary industries are in great need of low-cost power because the secondary industries that undertake casting, machining, and fabrication of various products can, as present contracts terminate, actively outbid them. The primary producers are consequently driven ever further afield in the search for low-cost power. The inevitable trend seems to be that raw products will be transported to the remote areas where large power potentials can be developed and where there will be no invasion of secondary industries in the power field. That is why large industrial organizations in Canada, the United States, and Europe also—have become so interested in the power potentials of the Canadian north.

Power development in our northern areas is expensive, and physical characteristics must be favourable to obtain low-cost power. The maximum and most beneficial use of water is an essential factor. Eventually a northerly limit will be reached where water power cannot compete with the output of thermal stations near industrial centres.

Northwest Power Industries Limited hopes to market much of its power in the base-metal fields, and in the fields of forest products, chemicals and plastics.

Aluminum is one of the great users of power—each pound requiring approximately 10 kwh. In 1954 the free world production of primary aluminum was 2.5 million metric tons. For 1975, the demand is forecast at between seven and ten million tons. Under present processes one million metric tons of aluminum per year require an installation of 2,500,000 kw. or 3,330,000 h.p. The transition from iron ore to crude steel requires 4 kwh. per lb. The free-world output of crude steel in 1954 was 185-million metric tons. The 1975 demand is forecast at 239-million tons.

In 1956, Canada's installed generating equipment was 15.9 million kw. In 1975, the electrical demand of Canada is forecast at double this figure. For the United States the installed figure in 1955 was 130.4-million kw. In 1975 the United States' demand is estimated at over two and one-half times the latter figure.

These few examples indicate the great increase required in power installations and output to meet future demands. Hydro-electric plants in the Canadian north-west have, to date, been developed close to firm markets and centres of population, subject to reasonable construction costs. A two-way trend is now noticeable. Power sites not regarded as economic some years ago are now being developed or re-examined, and major power potentials large enough to accommodate several primary industries are being investigated. Yukon river power falls in the latter category because not only is its potential large enough to handle ores from many parts of the world but it will be available at comparatively low cost for all mining and forest product requirements within transmitting distance. At the present time there are within reach of Yukon river power more than twenty large mineral deposits including numerous mines in various stages of development.

General

The project has provided a fascinating engineering study not only because of the wide scope of its problems ranging from hydro-electric matters to international ones but because it represents another step towards bringing raw materials to power supply for processing on a large scale.

Probably no major development in the Canadian northwest is linked more closely with, or will stimulate more the development of Canada's natural resources. It will improve transportation facilities, encourage exploration and surveys of all kinds, and bring settlement and stability to unpopulated areas. Yukon power can be a prime factor in establishing an industrial empire in Canada's northern regions.

In conclusion, the writer wishes to express his appreciation of the valuable co-operation and advice given by Dr. T. H. Hogg on the many problems associated with the Yukon River Project. As consultant over many years to the Ventures group, his great knowledge and experience were always available.

TRANSACTIONS

OF THE ENGINEERING INSTITUTE OF CANADA

The first issue of this new publication has been mailed to members of the Institute this month. It contains engineering papers, as follows:

- **Engineering Problems Involving Pre-Consolidated Clay Shales, by R. M. Hardy, M.E.I.C.**
- **A Rapid Analytical Method for Calculating the Early Transient Temperature in a Composite Slab, by W. F. Campbell, M.E.I.C.**
- **Graphical Solution of Problems in Hydraulics by L. K. Templeman Kluit, M.E.I.C.**
- **Fluid Friction in Partially Filled Circular Conduits, by D. G. Stephenson.**

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Contents - December 1957

(19,500 copies of this issue printed)

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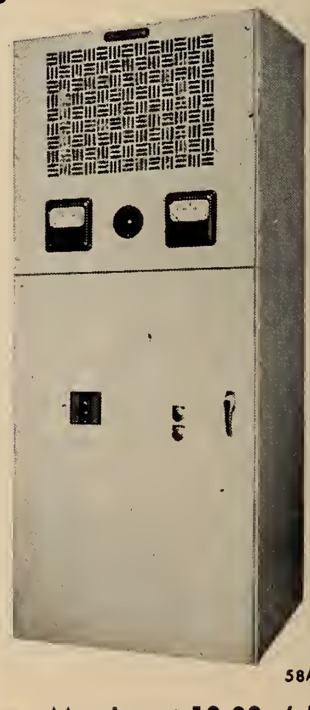

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Foundations for the Queen Elizabeth Hotel

O. Duskes, M.E.I.C.
Construction Engineer,
Montreal Terminal Development, Canadian National Railways

THE HOTEL is a structural steel frame building of more or less conventional construction resting on concrete foundations which in turn are founded on natural limestone. Only two features in the construction of the foundations might be of interest to you. The first was the problem of building a retaining wall up to 55 feet high along the east side of Mansfield Street without generating any condition that might result in damage to St. James Cathedral located on the west side of the street. The second problem was of much less consequence but it was caused by the necessity to impose loads of 25 tons per square foot on the surface of limestone which in places was of quite doubtful capacity.

This paper will deal mainly with a description of these two problems and with the methods of construction that were used.

St. James Cathedral is a large heavy masonry structure. The masonry foundations rest on natural soil a few feet below the surface of the ground. The structure shows some indications of localized settlement of foundations. Before any work was started on the hotel this church building was examined very carefully by C.N.R. engineers and also by an independent committee. It was the opinion of all concerned that the hotel foundations must be so constructed that the earth under the church foundations did not move laterally or vertically and that vibrations caused by dynamite and demolition must be kept down.

Before the hotel construction the east side of Mansfield Street was supported by natural undisturbed earth with a berm 6 to 10 feet wide on top and a slope of 1½ horizontal to 1 vertical. This earth slope was

Fig. 1

The new Queen Elizabeth Hotel in Montreal, belonging to the Canadian National Railways, adjoins the Catholic Cathedral of St. James. One had to avoid damage to the Cathedral during excavation and construction of the hotel, and when a 55-foot retaining wall was built between the two sites. A further problem concerned the necessity to impose loads of 25 tons per square foot on limestone of doubtful capacity. This paper deals with the problems.

about 30 feet high on top of rock. As the result of considerable engineering thought and study it was decided that the only safe procedure was to build the retaining wall first and remove the earth and rock from the east side of Mansfield Street after the wall was completed.

The retaining wall is 50 feet high above excavated rock level at Dorchester Street and 40 feet high at Belmont Street; it is 380 feet long. In effect the wall consists of a reinforced concrete slab 2 feet thick at the top and 3 feet thick at the bottom. The bottom of the slab is anchored about 5 feet into solid rock and is supported horizontally for its full length at an elevation about 20 feet above excavated rock level by a heavy reinforced concrete beam. This beam is supported horizontally at about 25 foot centres by concrete buttresses built on the east side of the wall. In effect the vertical wall acts as a vertical cantilever, loaded by the earth on the west face and the reactions from this load taken by the rock into which the toe of the wall is bedded and by the horizontal concrete beam 20 feet above the rock.

The construction method used was as follows: a vertical trench 6 feet wide was excavated full length of the retaining wall—the remaining portion of the earth slope being left in place. Simultaneously tunnels were excavated at track level at the site of each buttress to intersect the vertical trench.

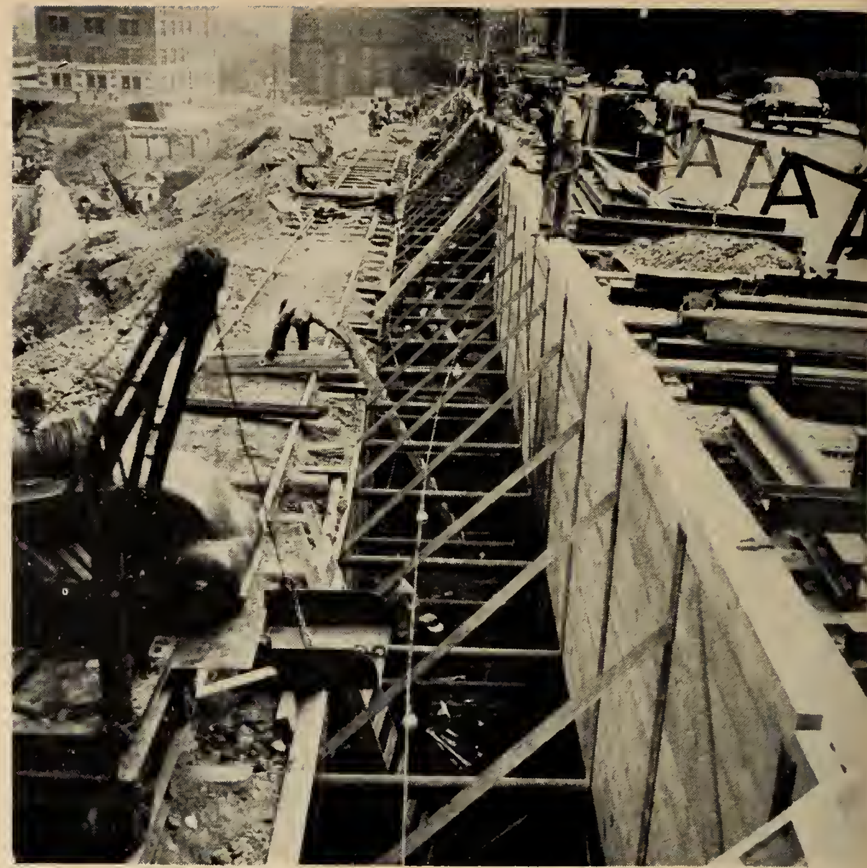


Fig. 2 (top)

Fig. 3 (left)

Figure 1 shows the first stage of the excavation for the vertical retaining wall. As can be seen, a cut 6 ft. deep was first made with a bulldozer, the excavated material being pushed over the slope. Excavation of the trench to a depth of 4 ft. was the next step, this being immediately followed by the placing of pre-fabricated shoring from street level to the bottom of this 4 foot trench.

Figure 2 shows the next stage. The construction of the shoring consisted of 6 inch wide flange beams at 15½ lb. placed vertically at 6 foot centres on both sides of the trench. The sheeting was 4 inch plank fitted between the flanges of the beams and the struts were 4 inch standard weight steel pipes. The beams were fitted into the excavated trench in 4 foot vertical lifts and were butt welded at the ends. The pipes had plates welded on the ends and these were in turn welded to the beams lapping the beam joints.

The excavation was done by hand with the aid of air-operated clay diggers. The excavated material was loaded into small skips which were hoisted by air winches and derricks mounted on railway lorries which also carried small air compressors. The lorries travelled on standard gauge track constructed alongside the trench and thus each rig was able to serve several crews of muckers. The excavated material was disposed of by swinging the derrick and dumping over the slope. The derricks were also employed to lower the shoring material in the trench where required.

The excavation was deepened in increments of 4 feet. Alternate sections 6 feet long were excavated, shoring placed, followed by excavation of the intermediate sections and completion of the shoring. Thus at any time a maximum of 50 per cent of the 4 foot cut was unsupported.

The work was done very carefully and the spaces behind the planks were filled and tamped with earth. In spite of these precautions a portion of the trench was observed to go off line. Though the movement was very small it continued to increase over several days and was the subject of considerable concern.

Fig. 4

Cause of Movement

The movement was probably due to one or more of the following:

(1) The packing behind the planks was perhaps not perfect and the movement might be due to slack being taken up.

(2) The weather had been very wet and seepage into the ground, especially on the slope side of the trench, might have been sufficient to lower the resistance of the earth to pressure from the shores and local movement took place.

(3) The entire earth slope might be failing. This of course could have been disastrous. It was happily ruled out quite early by careful and regular measurements.

Fig. 5

The movement of the trench was quite small and not serious but it did continue. To stop it holes were drilled through the shoring planks on the east side and grout was pumped to fill the voids. The track was lifted and replaced on a 6 inch concrete pavement. Whatever the cause, these two remedies were sufficient to permanently stop the movement of the shoring. The balance of the packing behind the shoring planks was done with crushed stone and in particularly bad spots with lean concrete.

Figure 3 is a view of the interior of the trench showing some of the reinforcing steel in place. The retaining wall, above the 90 level, enclosed space intended for high class occupancy and first class waterproofing was essential. As the wet side of the wall would not be exposed for waterproofing after the concrete was in place it was decided to place membrane waterproofing on the exposed face of the shoring planks. The membrane consisted of two ply felt and three ply asphalt saturated cotton fabric, each layer mopped on with hot asphalt. To protect the membrane from being punctured during the placing of the reinforcing steel it was covered with ¼ in. masonite glued in place with hot asphalt.

Figure 4 shows much the same as

Fig. 3. This view was taken near the top of the trench. The masonite was omitted here because there was less danger from the reinforcing steel. Conscious of the danger of fire in the trench, due to the presence of form lumber and asphalt, precautions included the employment of pensioned city firemen for fire prevention, and the posting of "No Smoking" signs in English, French, and Italian.

At this time the wall has been in place for almost two years—no evidence of seepage or leakage of water through the wall has been observed.

Figure 5 is a general view from Dorchester Street bridge of the earth slope and shows the tunnel portals. The portals were driven 4 feet wide and 7 feet high and served as accesses to the main portions of the tunnels at the buttress locations.

Figure 6 shows the interior of a buttress tunnel. The shoring is much the same as in the trench for the vertical wall, 3 in. plank sheeting was used for the walls and 4 in. plank for the roof. The WF beams were centred 3 feet to 6 feet depending on the superimposed load which increased towards the street. Each set was strutted with steel pipes top and bottom with intermediate struts where the side exceeded 7 ft. 6 in. in height.

The earth excavation was progressed in increments equal to the spacing of the shoring sets—3 ft. to 6 ft. A pilot tunnel was driven at the top, a few feet in advance of the main tunnel to provide space for temporary plank protection at the roof. The ground stood well during excavation and no temporary side protection was required. The excavation was done with air-operated clay diggers, the loosened material being loaded into wheelbarrows and dumped at the tunnel portals where it was later loaded into trucks with front end loaders.

Only experienced miners were employed in this work. To stimulate progress a bonus system was put into effect.

Fig. 6 (right)

Fig. 7 (below)

When this photograph was taken the earth had been excavated, during driving of the tunnel, to the surface of the rock and rock excavation was in progress. The beams were pulled together with turnbuckles to avoid spreading—which spreading, if it took place, would release the shoring planks.

The concreting of the walls was done by discharging from transit mix trucks located on Mansfield Street into "elephant trunks" spaced at about 15 foot intervals along the length of the wall.

Concrete for the buttresses was discharged into 6 in. "pump-crete" pipes vertically down the wall trench changing to horizontal through a 90 deg. bend. The horizontal pipe was suspended by hangers from the trench roof. No pump was used—the head of concrete in the vertical pipes was sufficient to keep the concrete moving. Any interruption, no matter how slight, was sufficient to cause the concrete to stick in the pipes, making it necessary to dismantle and clean out the entire system. After the first few days, the crews became accustomed to this operation and delays were reduced to a minimum.

An external vibrator at the 90 deg. bend was tried as an aid to maintain the flow but was soon discarded when it was found that it tended to increase packing of the concrete, especially at the bend. The slump of the concrete was carefully maintained at 1½ to 3 inches. Concrete was discharged directly into forms and there was little or no segregation of the concrete. The concrete was vibrated with internal vibrators. Stripping of the forms disclosed well placed concrete with practically no honeycombing.

Figure 8 shows excavation of the earth slope. A bulldozer was used to excavate down to the elevation of the tops of the buttresses, the balance of the excavation being performed by shovels standing at track level. Fig. 9 shows the excavation well advanced. Fig. 10 shows some of the buttresses and part of the wall after stripping. The steel pipe struts are cast into and remain permanently in the wall.

In the construction of foundations for the Aviation Building it was necessary to dig and shore open trenches some 30 to 35 feet deep in the material overlying the rock. These were shored with 4 in. hardwood plank with 6 in. x 6 in. hardwood walers and 6 in. x 6 in. hardwood struts. In many places the pressure on the struts was so great that the ends of struts crushed into the hardwood walers as much as 2 in. at each end and quite a few of the 6 in. x 6 in. hardwood struts failed in compression. This experience forced the use of 6 in. steel beams as walers and 4 in. steel pipe for struts and there were no failures of either.

This completes the illustrations in connection with the retaining wall. It is of interest here to state that the wall was constructed with no settlement or loss of material on the west side—and therefore with no possible prejudice to the physical condition of the Church structure.

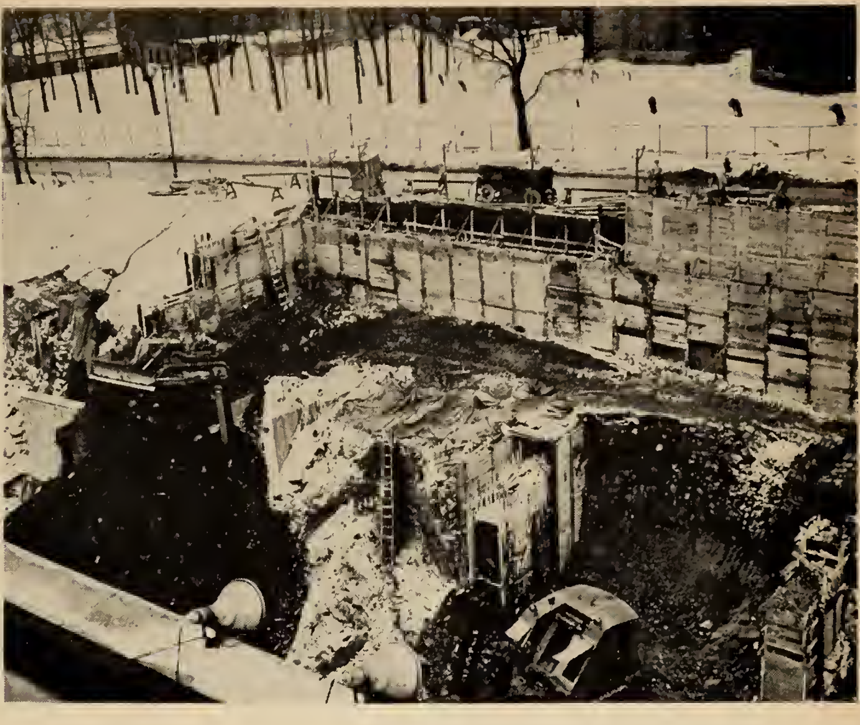


Fig. 8

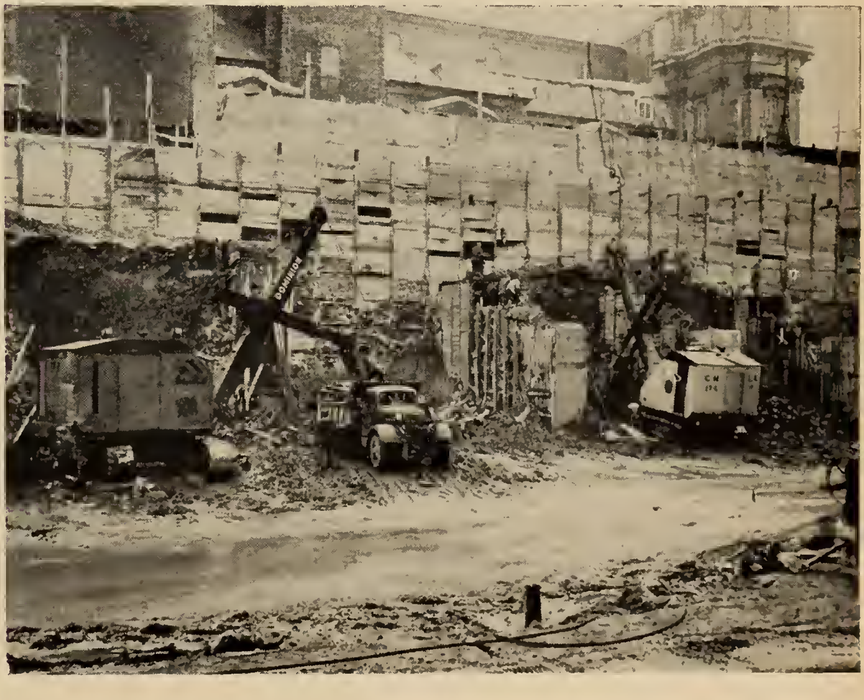
Rock Excavation for Foundations

The site of the building is underlain by limestone, and the foundations were designed with a bearing load of 25 tons per square foot on the rock. The limestone is bedded horizontally, as stone this is good solid hard material but it contains seams and pockets varying in thickness from mere cracks to 4 or more inches. The presence of these seams could not be ignored as in some cases the material in the seams is plastic and could cause building settlement if existing at a shallow depth below a column pedestal.

At each column location a hole 2⅜ in. diameter was drilled 20 ft. deep with a diamond drill, using a solid bit as no core was required. The rock was investigated with a home-made device consisting of a pole about 1½ in. diam. with a sharpened nail attached at right angles near one end. A tape graduated in feet and inches was attached to the pole with the zero end at the nail. The side of the hole was scratched with the nail and the locations and sizes of the seams were discovered and noted. This device is primitive but has proved to be effective.

Seams at a depth of about a foot or less were eliminated by carrying the excavations to their elevations. Deeper seams were assessed by assuming a load distribution through the rock at a 45° angle and the unit load calculated at the elevation of the seam. Where this unit load did not exceed 4 to 5 tons per square foot the foundation was accepted—otherwise the excavation was deep-

Fig. 9



ened to the seam elevation. In some cases a succession of seams was found extending to considerable depth. In these cases the dimensions of the pedestals were increased to reduce the unit loads to acceptable limits.

The rock excavation was accomplished by drilling and blasting. Fig. 11 is a general view of this work being performed in the open. Fig. 12 shows rock excavation being carried out between station platforms. Here the rock was handled by a crane mounted on a flat car to raise the crane so that it could swing over the tops of the station platforms. The rock was dumped into railway cars because highway trucks could not operate in these places.

The concrete was deposited in the pits—no forms were used—to within 6 in. of final elevation. The screeds for the final finish consisted of two 4 in. x 4 in. x ½ in. steel angles of suitable length with one edge machined. The angles were each mounted on two 1-in. bolts, previously cast in the concrete and brought to level and held securely by two nuts on each bolt, one above and one below the horizontal leg of the angle. The concrete was deposited between the angles and struck off with a straight edge made of a 1 in. x 4 in. steel flat with one edge machined. The resulting surfaces were uniformly flat and level and at correct elevation. After the caps were cured, centre lines were scribed on the surfaces with carboloy-tipped scribers to locate the column centres. It is a tribute to the work of our surveyors and steel fabricators that the steel superstructure of this building went together perfectly and no trouble was experienced during erection because of bad fit.

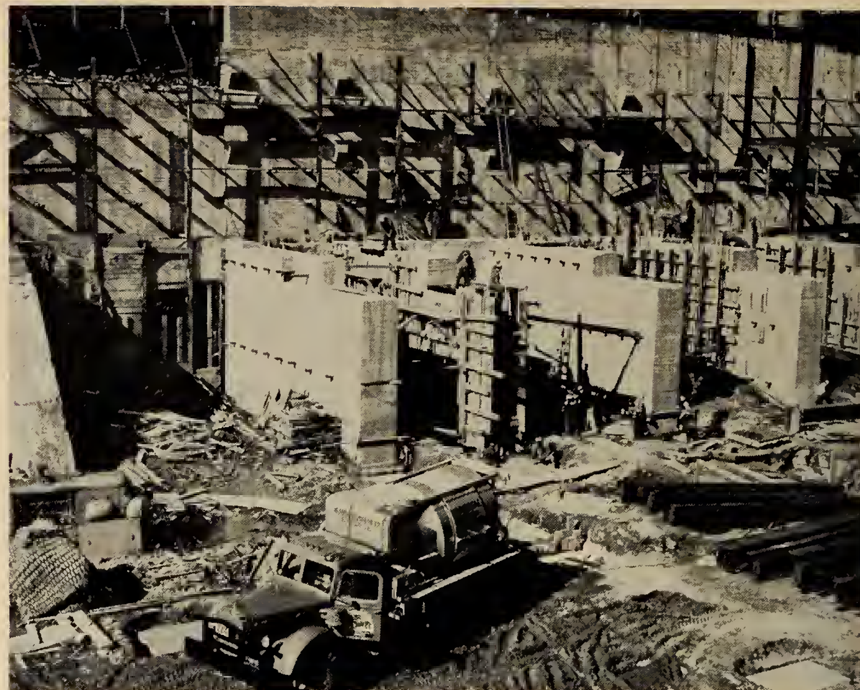


Fig. 10

Vibration

A considerable area below the track level is developed for the express, baggage, and mail handling departments. The tracks over this "sub-track" area are carried on a reinforced concrete structure which is subject to vibration from moving trains. The building columns in this area pass through openings in the track slab, beside and on the same footings as track structure columns. In areas where there is no sub-track structure the building columns are supported on footings immediately adjacent to railway tracks. These footings are also subject to vibrations.

The overlying building is to be a hotel, and no vibrations from trains must get into this structure. The first few buildings constructed over the tracks in Grand Central Terminal in New York were not properly isolated, and trains passing underneath can be both heard and felt throughout the entire height of the building. Intensive study by experts resulted in a theory which proved to be simple, cheap, and effective. If one stretches a skin of any material tightly over an opening and tap it, it vibrates and the period of vibration depends on only two factors—the nature of the material in the skin and the degree of tension or stress. If one stretches two layers of similar material in contact over an opening and tap it there is little vibration. The material in each layer is the same but there is just enough difference in tension or stress to make each skin have a different natural period of vibration and thus

Fig. 11

the vibrations in each skin tend to dampen those in the other contacting skin. If two or more skins of different material are stretched in contact over an opening and one tries to induce vibration, they will not vibrate, as each layer has a different vibration period and each layer acts to dampen the vibrations in all contacting layers.

Isolation Pad

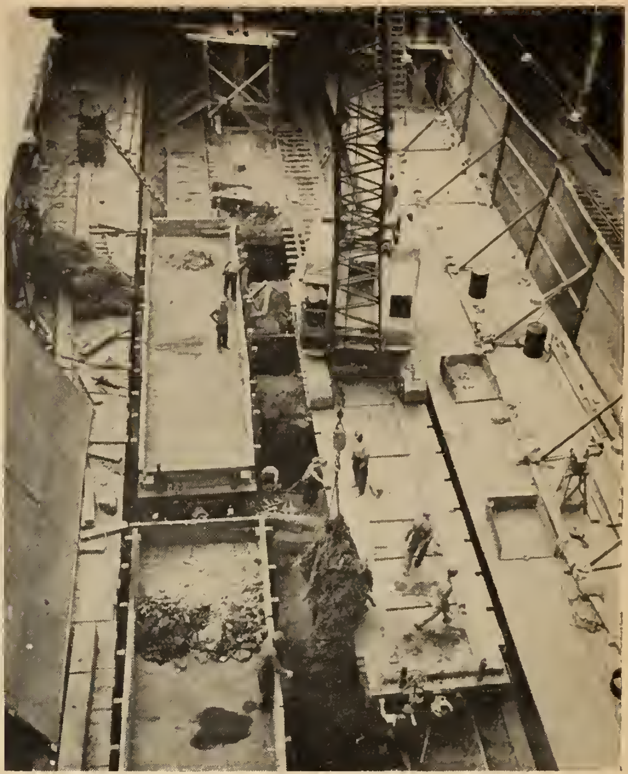
The explanation is complicated—the resulting isolation pad is simple. Five thin layers of dissimilar materials in contact and under a stress of 800 to 1000 p.s.i. in compression. In more detail, the isolation pad consists of ⅛ in. lead, ⅜ in. asbestos board, 1/16 in. steel, ⅜ in. asbestos board and ⅛ in. lead. The lead is bent down at the edges and the top and bottom layers soldered together to make a water-tight envelope. The pad is coated with asphalt roofing paint. No anchor bolts are permissible finally. (Fig. 13 indicates anchor bolts.) These are used only during erection and are later cut off.

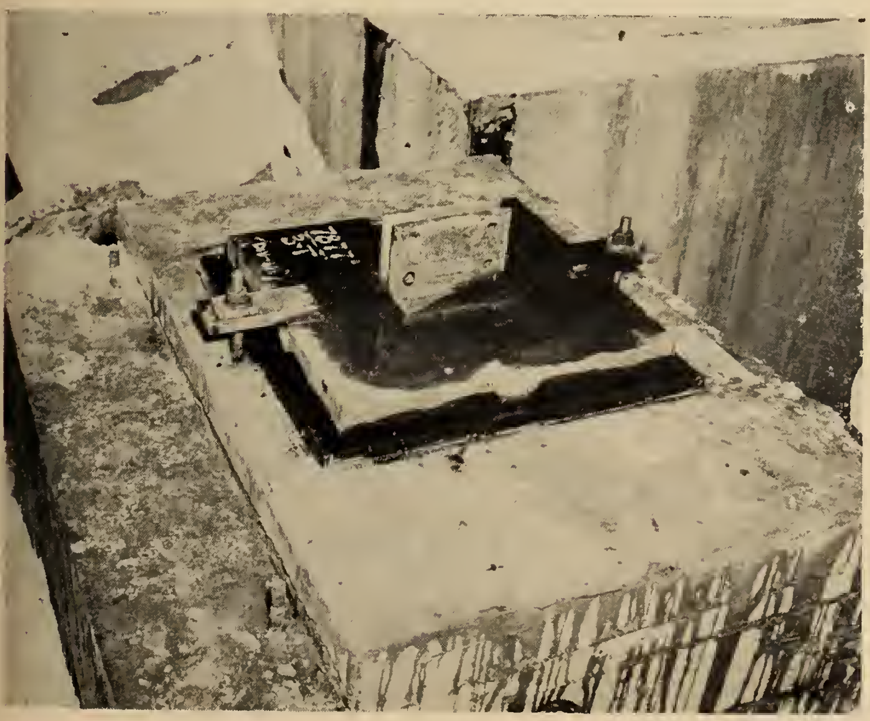
Above the isolation pads the fireproof column is isolated from all other vibrating material with 2 in. of cork board applied in 1 in. layers with staggered joints. The installation of this cork board must be done with great care as there must be no concrete fins through the cork to transmit vibration.

These pads have been used in many places—and they are 100% effective.

Fig. 12 (right)

Fig. 13 (below)





Underpinning And Strengthening

At the juncture of the station building and the hotel the columns are common. In some cases the station columns were adequate to carry the increased loads and it was necessary only to expose the existing columns by removing the masonry and concrete, drilling holes, and bolting on beam seats. (Fig. 14.)

Where existing columns were inadequate for the increased load they were stripped of their concrete fireproofing and strengthened by the addition of angles, plates or tees bolted or rivetted in place—provided that the foundations were adequate. (Fig. 15.)

Where both the columns and the foundations were inadequate the load was taken, temporarily, by wooden posts, the columns removed, the foundations prepared, and new columns erected.

Fig. 16 shows what was done in one case where both the column and the foundation were inadequate and where it was very difficult to use temporary posts. In this case the column was first strengthened by plates rivetted on the flanges. A jacking girder was bolted on and the load taken off the foundation by four hydraulic jacks supported on the track structure. The existing foundation was extended and the jacks removed, with the jacking girder.

Site Difficulties

The hotel is situated over some eleven railway tracks (Fig. 17 and 18). Of these, only two could be taken out of operation at any one time. As finally worked out, the sequence for construction over any pair of tracks was:

(1) Remove overhead traction wires.

(2) Remove services, electrical, mechanical, etc.

(3) Demolish existing plaza slab.

(4) Prepare foundations.

(5) Replace traction wires and put tracks into service.

This sequence was repeated until all foundations were prepared.

Similar procedure was followed for steel erection and also for construction of concrete floor slab at the plaza level.

With the full co-operation of the operating department of the railway and all the contractors concerned this

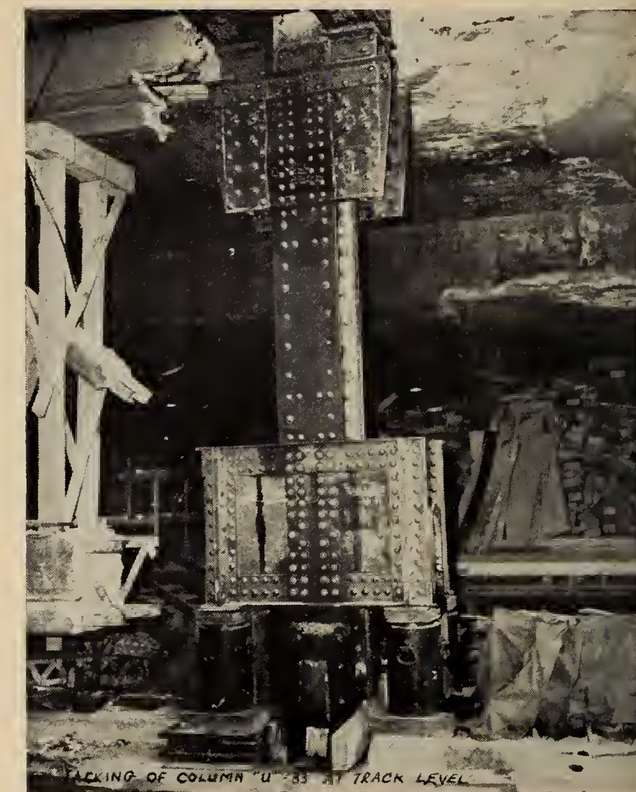
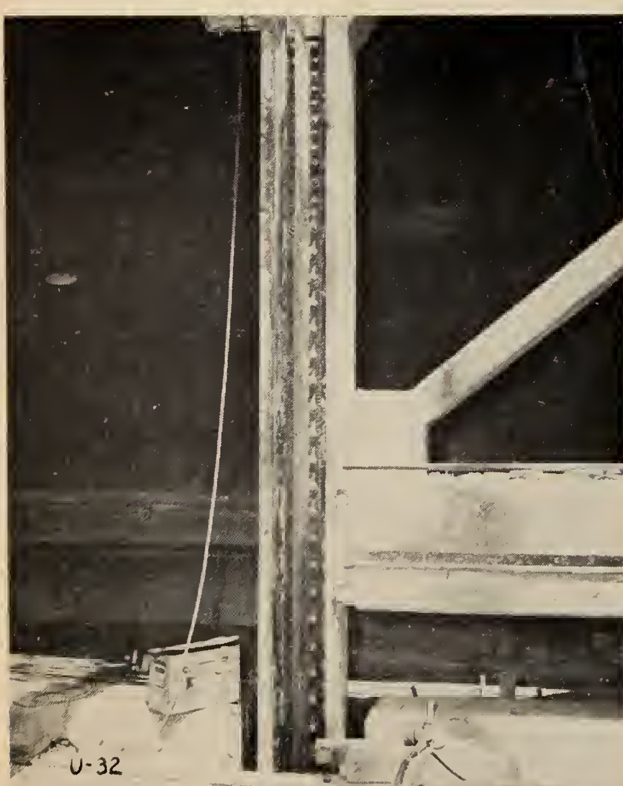


Fig. 14 (above); Fig. 15 (below)

Fig. 16 (above); Fig. 17 (below)



operation was completed with a minimum of interference with train service and in safety to the travelling public.

The Cathedral facing the hotel is very sensitive to vibration from blasting and from the demolition ball. To control the situation a vibration recording instrument was set up in the Cathedral to measure vibration. This instrument, with its attendant, was used at all times during the course of the demolition and the rock excavation. The effect of each blast was recorded, and the effect of the demolition ball in setting up vibration was noted. These vibrations were kept below predetermined limits by limiting the amount of explosive used and where necessary altering the demolition procedure. As a further safeguard, an independent committee, consisting of an architect and two engineers, was retained. The committee examined the Cathedral before the work was started, during progress of the work, and finally when the excavation, demolition, and retaining wall were complete. The committee reported jointly to the Cathedral authorities and to the railway company. No damage to the Cathedral building was recorded and good relations were maintained with the Cathedral authorities.

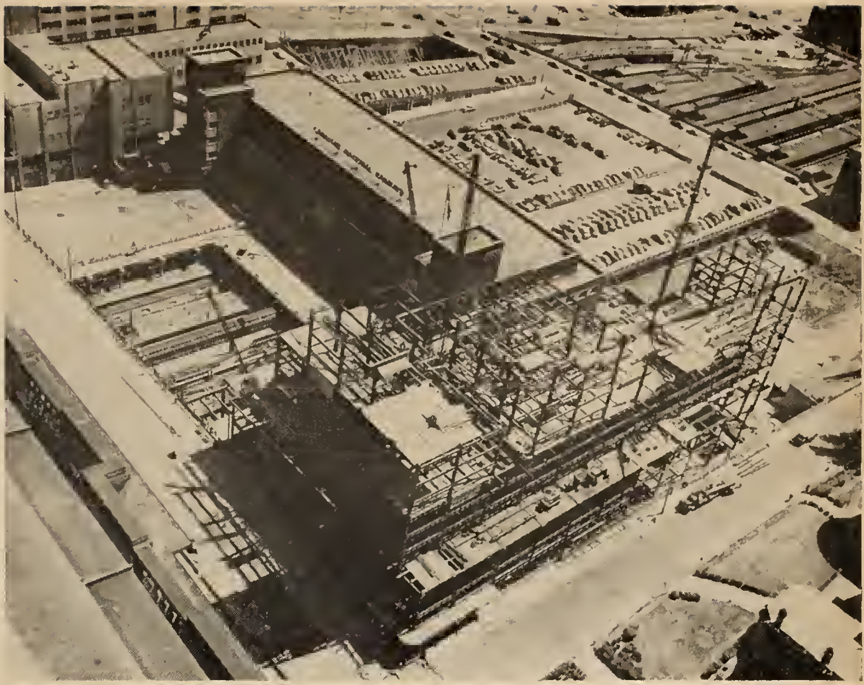


Fig. 18

Acknowledgments

I would like to express thanks to A. V. Johnston, system chief engineer, Canadian National Railways, for permission to publish this paper, and to R. O. Stewart, formerly chief engineer and now consulting engineer, C.N.R., for his guidance during the course of the construction.

Prestressed Wind Bracing in Queen Elizabeth Hotel

D. A. Chamberlain, JR.E.I.C.
Dominion Bridge Company Limited, Montreal

THE PROBLEM of overcoming wind forces in a tall, narrow building has always presented certain difficulties. The Queen Elizabeth Hotel in Montreal being built by the Canadian National Railways is no exception. The structural designers found it necessary to develop some type of adequate wind bracing system, which, to suit the architects' requirements, had to be within as thin partitions as possible and at the same time assure that no damage to the partitions could occur by transverse deformation of the diagonal members. The solution of this problem is the topic of this paper, pretensioned wind bracing enclosed within narrow partitions.

The Queen Elizabeth Hotel is a 21 floor building with a 2 floor penthouse. Below the main floor are three levels, the lower level, the station level and the track level. The track level which is about 55 feet below the main floor is open to the atmosphere to allow the passage of trains under the hotel and the station course. The second and third floors, above the main floor, contain the dining rooms, banquet rooms and convention halls. Above the third floor are the bedroom floors which are all similar in plan.

It was found necessary to develop some type of adequate wind bracing system to overcome the effects of wind forces in the Queen Elizabeth Hotel, which is a tall narrow building. The design was limited by the architect's requirements. This paper describes the eventual solution of the problem—this was the use of pretensioned wind bracing enclosed in narrow partitions.

Design History

The original design investigations were based on a rigid frame building with moment connections on all beams to take the wind force. The unusual floor framing (as seen in Figure 1) has no direct link between the two interior columns and consequently, the wind must be taken by two single bay towers instead of one three bay tower. This factor would have made the beams very deep and the moment connections very wide in order to obtain the required number of tension rivets. The depth of beam and the width of flange were of prime importance architecturally, as there were to be no hung ceilings in the bedroom floors and large beams would break the appearance of the wall. Hence moment connections were rejected for the bedroom floors but retained on the lower floors where large beams were not objectionable.

Bracing

Among the ideas considered was the theory of one wing of the building supporting the other through the concrete floor slab. This theory has been used successfully in many cases but did not prove too satisfactory in this case due to the "L" shape of the building and the break in the slab, for elevator shafts, at the highly stressed inside heel of the "L".

Angle or channel bracing members were suggested, but the resulting partition thickness would be about 12 inches as compared with the standard, non-braced, interior partition of 4 in. thickness.

The shearwalls were to be of reinforced concrete, poured in two pours to form a cruciform section, in elevation, with the floor slab. The partition thickness resulting from the use of shearwalls would be 6 inches on the bedroom floors.

Some of the disadvantages of concrete shearwalls were:

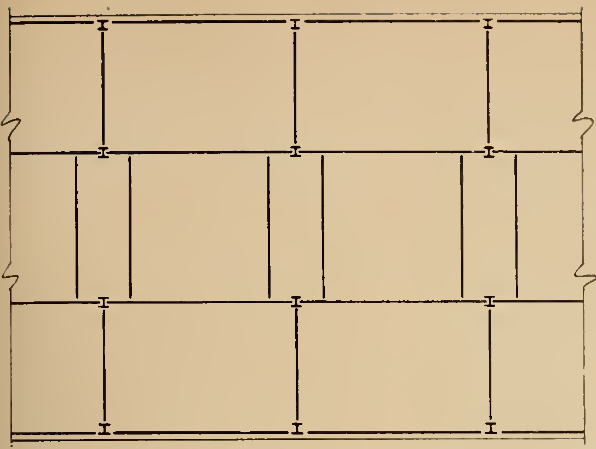
(a) they restricted all future alterations in the building;

(b) they would have to be interrupted between the 10th and 11th floors to allow passage of large air conditioning ducts above a hung ceiling (there being a larger floor to floor dimension than other bedroom floors);

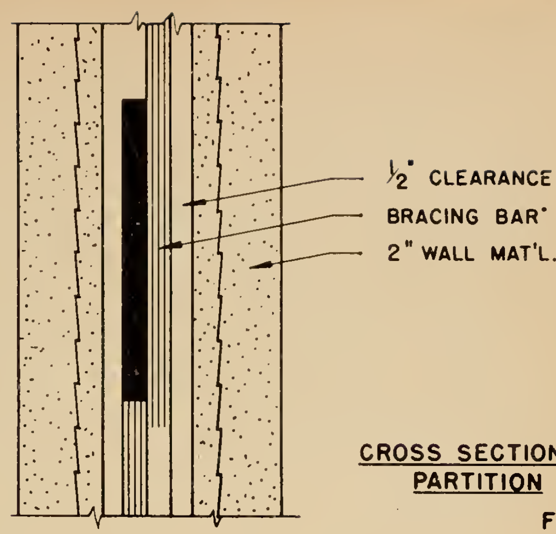
(c) the dead load on the footings, and columns would be substantially increased;

(d) they would cause pouring delays due to necessary sequence of walls and floors.

Only a nominal stiffness is provided in the steel framing of the buildings and columns would be substanare of the moment type but only designed for the size of the relatively shallow beams. About 5 per cent of the wind on the finished building could be taken on these beam con-



TYPICAL STEEL FRAMING FOR BEDROOM FLOORS
FIG. 1.

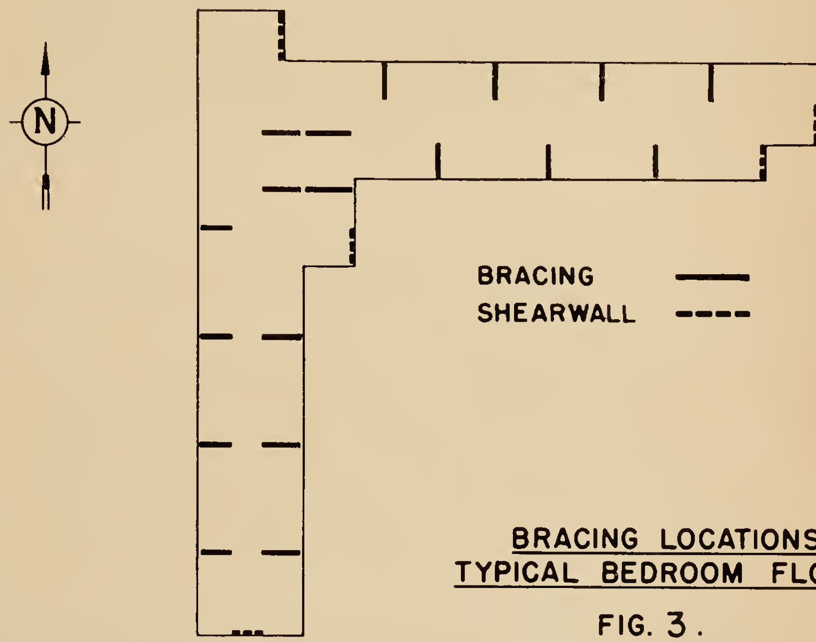


CROSS SECTION OF PARTITION
FIG. 2.

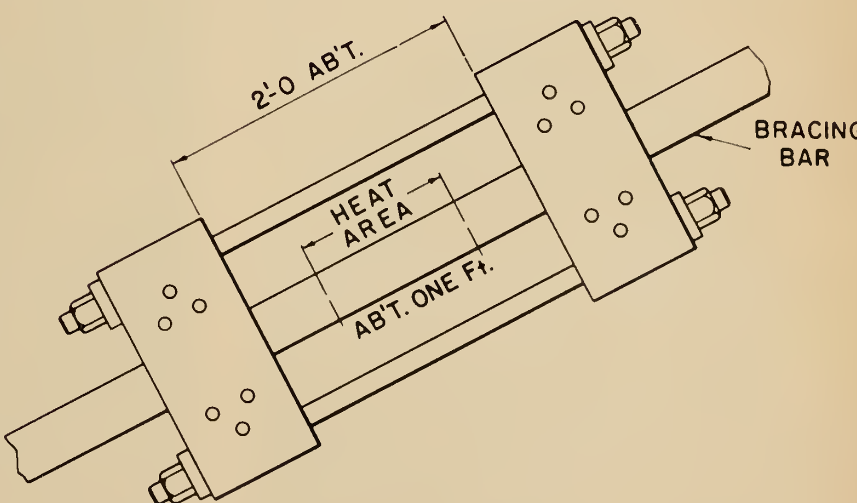
nections whereas about 45 per cent of the total wind force would act on the bare steel structure. It became apparent that the pouring of concrete shearwalls must follow closely behind the erection of the steel structure if major erection bracing were to be omitted. Steel erection can proceed more rapidly than forming and pouring of concrete, so it was felt that temporary erection bracing would be necessary in order that the erection procedure would not be unduly interrupted.

The temporary erection bracing required made it more unlikely that the shearwall solution was economical. The system of steel bracing was again considered and it was decided to use steel plate bracing bars varying in width from 6 in. to 8 in. and in thickness from ⅜ in. to ⅞ in. Details were so devised that this bracing could be used as temporary construction bracing and later pretensioned as permanent bracing. In order to enclose this bracing in a confined area, it was necessary to pretension the bars to a point where, with maximum wind acting on the structure, no bracing bar would go into compression. This enabled the architects to enclose the bracing in a narrow partition without the possibility of cracking walls. The composition of the partition. is 2 in. plaster faced wall material, 2 in or 3 in. air space for bracing bars depending on bar thickness and 2 in. wall material giving a total partition thickness of 6 in. to 7 in. A cross section of a typical partition is shown in Fig. 2.

The use of shearwalls was maintained in exterior walls and in some cases around the elevator shafts in the lower floors but, in general, pre-



BRACING LOCATIONS
TYPICAL BEDROOM FLOOR
FIG. 3.



EQUIPMENT FOR SHORTENING BAR BY UPSETTING
FIG. 4.

tensioned bracing bars replaced concrete shearwalls. The location of shearwalls and bracing panels on the bedroom floors are shown in Figure 3.

Methods of Pretensioning

There are two methods of prestressing wind bracing that have been used in buildings recently. The first is by heating the bar after both ends have been fastened and applying a compressive force on the heated area sufficiently large to upset the bar, and allowing the heated area to cool with the compressive force still acting. This method has been used for some years in bridge work for tightening eye bar truss members. The main disadvantages are the lack of flexibility in adjusting stress after the upset has been made and the inability to use the system easily as a construction bracing system before the final prestressing is carried out. The equipment sometimes used is shown in Figure 4, and consists of two clamps which are clamped to the bracing bar. The area between the clamps is heated by means of a torch to a cherry red color at which time the clamps are drawn together with two large bolts until the required upset is obtained. The clamps are maintained until the bar has cooled and the result is a tensioned bar with a visible upset.

The second method to be described is that used on the Queen Elizabeth Hotel. By heating the bar and clamping a free end when the required elongation is obtained, the result after cooling is a tension proportional to the measured elongation.

Prestressing Procedure

The procedure used started with the initial erection of the bars as temporary erection bracing. Figure 5 shows a typical bracing panel detail. The gussets were shop rivetted to double channel beams framing between columns. These columns had shop connected angles to which the gussets were field welded. The upper jaw plates were shop welded to the bracing bar. Both gussets and jaw plates had assembly holes punched for field erection. The bar was erected and loosely bolted to gussets at top and bottom with ⅞ in. dia. bolts "a" and "b". With the columns plumbed, the gussets were welded to the column connection angles and bolts "a" tightened.

The lower jaw plates were then pushed down as far as ¾ in. dia. bolts "c" in 15/16 in. dia. holes would allow. Bolts "b" allowed this movement of jaw plates as the holes in the gussets were 1-3 16 in. dia. while

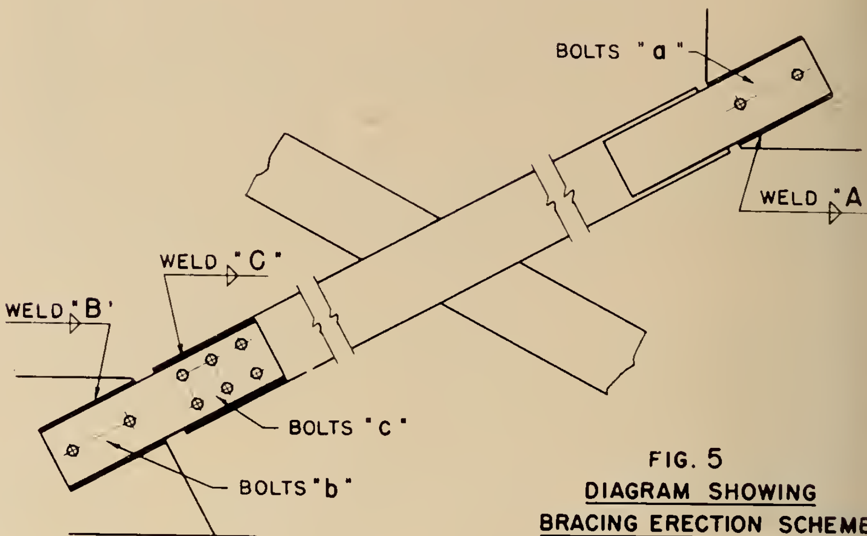


FIG. 5
DIAGRAM SHOWING
BRACING ERECTION SCHEME

Fig. 6. Below, left: View of hotel at beginning of pretensioning.

Fig. 7. Right: General setup of heaters.

the holes in the jaw plates were only 15/16 in. dia. The bolts "b" and "c" were tightened and the jaw plates were welded to the gussets at top and bottom, welds "A" and "B". This erection procedure provided a miss-match of holes by about ⅛ in. between the lower jaw plates and the bracing bar. To obtain an initial tension as temporary erection bracing, these holes were drifted with 15/16 in. dia. drift pins and bolted with suitable bolts "c". This provided an active system of wind bracing which kept the building in plumb during erection and until the prestressing operation could commence.

The steel erection was completed when the general contractor was just starting to pour floor slabs on the lower floors. When this pouring reached about the tenth floor, the pretensioning procedure began. Figure 6 shows a view of the hotel building at the time when pretensioning started.

The prestressing was carried out one panel at a time, completing one floor before moving on to the next. It was also important that the prestressing be carried out under a poured floor. The explanation of this will be given later.

The field procedure was as follows. The bolts "c" were removed at the lower ends of a pair of bracing bars, and the bracing bars were supported from displacement between the jaw plates. If the bar was bowed, it was brought back into line with drift pins, care being taken not to introduce appreciable stress. The measuring device, basically a dial indicator, was placed at the free end of the bar and set to zero. Heaters were placed over the upper halves of the bracing bars, which were heated until the desired elongation was obtained. High strength bolts were then inserted and tightened to hold the tension in the bracing bar developed by cooling. The weld "C" was made for the full capacity of the bracing bar and all the bolts were then removed.

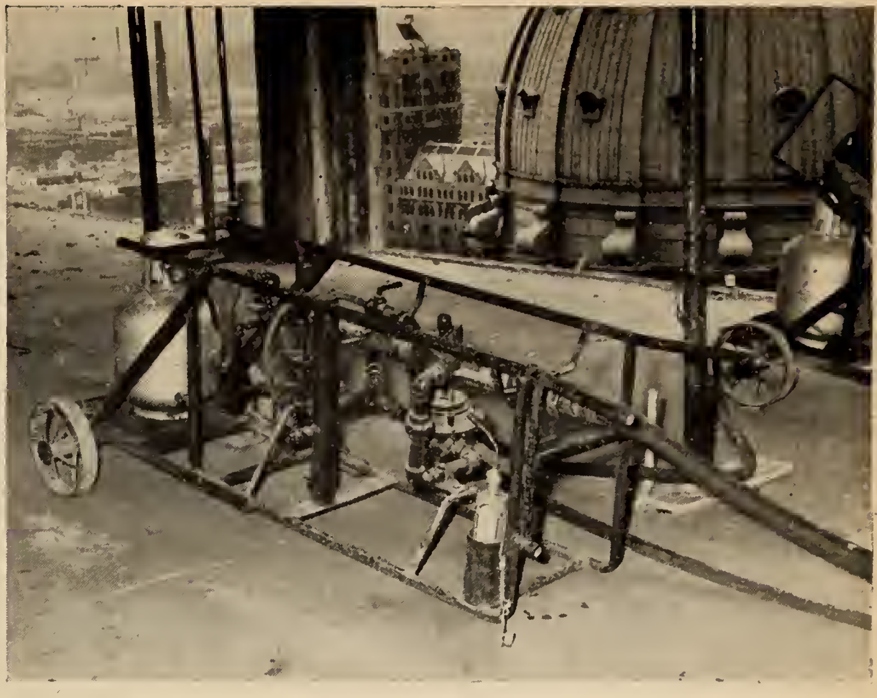


Fig. 8. Heating buggy.

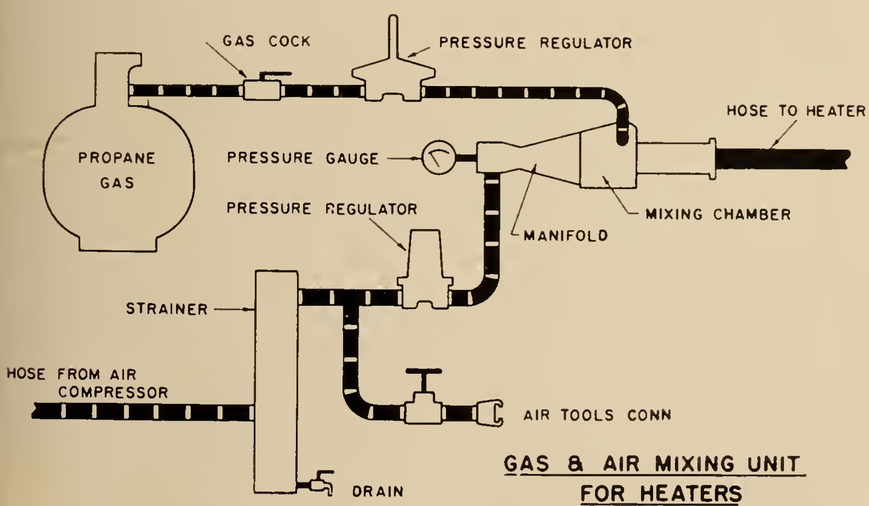
Equipment Used in Prestressing

Both bracing bars in one panel must be pretensioned concurrently and consequently, there are two complete sets of equipment, as seen in Fig. 7.

Each heater unit is mounted on a two-wheel buggy to facilitate movement. The buggy is a pipe assembly, as seen in Figure 8, which supports the gas bottle, manifold, valves, and pressure regulators. Above the manifold is a cradle where the heater unit may be placed when not in use.

The heaters burn propane gas mixed with compressed air. A schematic layout of the mixing unit is shown in Figure 9. After the air strainer is an outlet and valve which allows the connection of other air-operated tools. The propane supply is from a small cylinder mounted on the buggy. The gas passes through a control valve and a pressure regulator into the mixing chamber which is part of the manifold. Here the gas and air are mixed and flow under pressure through a flexible hose to the heater unit. The heater unit consists of two banks of 34 blast tips facing each other. The tips are mounted along two 1¼ in. diameter pipes, are enclosed in a cylindrical steel box about four feet long, slotted to allow it to be placed over the bracing bar. The heater was constructed so that, when placed over the bracing bar, the jets were protected from the wind and the heated area was shielded to minimize heat loss and to control the cooling rate.

At the lower end of the bracing bar a cradle type of support was used to keep the bracing bar in line between the jaw plates but allowing free movement in the direction of ex-



GAS & AIR MIXING UNIT FOR HEATERS

FIG. 9.

pansion. Figure 10 shows this cradle and the measuring device — a dial indicator which read in thousandths of an inch. The dial indicator on its stand was mounted on the bracing bar, and the plunger worked against an arm connected to the gusset or fixed end.

With the heater unit on the bracing bar and the temporary bolts "c" removed, the dial indicators were put in place and set to zero. Both heaters in one panel of bracing were lighted simultaneously by the use of a small gas torch. The expansion was watched on the dial indicators. Heating was continued beyond the required elongation to allow time for insertion of high-strength bolts and any necessary reaming. When cooling had proceeded to the point where the required elongation was obtained, the high-strength bolts were tightened by air-operated impact-wrenches and then checked with a torque wrench to provide recommended bolt tension. Figure 11 shows the bolting operation. The impact wrench and reamer were operated from the air outlet on the heater buggy so that only one line was required from the air supply; this was a 210 c.f.m. compressor located on the main floor with an air reservoir located higher in the building.

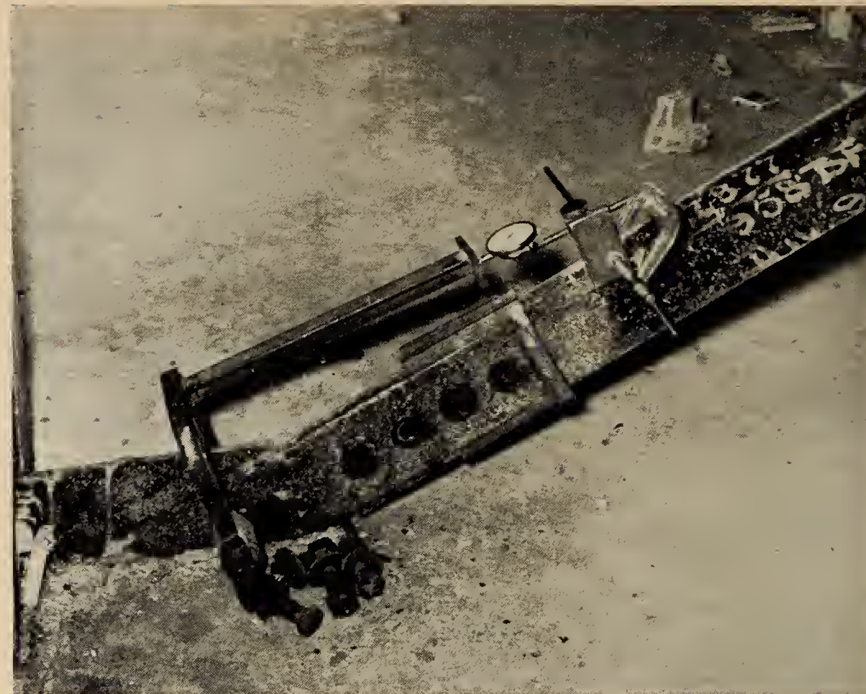


Fig. 10. Lower end of bracing bar showing measuring device.

The bolted connection, after cooling, held the bracing bar fixed due to the frictional effect of the high-strength bolts. The welded connection, Figure 12, was usually made a few days later, to complete cooling and allow an extensometer check before the final connection.

Technical Aspects

The desired stress in each bracing bar after pretensioning was 16,000 p.s.i., made up of 10,000 p.s.i. wind stress, 4000 p.s.i. dead load column shortening, and 2000 p.s.i. residual stress.

Fig. 11. Bolting with high strength bolts.

The stress in each bar was confirmed by extensometer readings (Fig. 13). The instrument used was a 10 in. Whittemore strain gauge. An initial reading was taken before the bracing bar was heated, but after the bolts were removed at the lower end, releasing the erection tension. The final reading was taken with the bar held in its expanded position and fully cooled. Two sets of readings were taken on each bar, one on each side, and averaged to give better accuracy. The difference in readings between final load and zero load gave the elongation in the measured length, from which the resulting stress could be calculated.

The effect of tensioning a panel of bracing on the surrounding structure is a shortening of the adjacent columns and beams above and below. Column shortening also occurs because of the addition of dead load on the structure above. Pretensioning followed closely behind the pouring of concrete floors, so some provision had to be made for column shortening due to increasing dead load. These operations were always carried out under at least one poured concrete floor, so that the concrete floor slab might act with the steel floor beam to form a composite strut.

The column shortening, and beam shortening due to the tensioning of bracing bars, was assumed in the beginning to be negligible. It was found, in practice, that there was about a 10 per cent drop in stress from that calculated for any given elongation. The calculated elongations were all increased by this amount, which proved to be satisfactory. The reasons for this drop in stress could have been elongation in the gussets and jaw plate connections as well as column and beam shortening.

Of the 16,000 p.s.i. originally introduced in the bracing bars, a gradual decrease was noticed as dead load was increased. Two test panels on the fifth floor were checked daily and records kept of the stress in each bar. Because test conditions were not like those found in a laboratory, the daily variations expected due to additional dead load and the effect of tensioning a panel directly above the test panel, were distorted due to inconsistent weather conditions. However, the trend showed a decrease in stress by about 2000 p.s.i. due to column shortening by the time prestressing was completed. At this time the progress of building construction was as shown in Figure 14. All the concrete floors and beam and column haunching were poured and about 15 of 21 floors of stone-faced exterior walls had been completed. The remaining six floors of exterior walls, all the interior partitions and floor finishes had yet to be installed. It was felt that the estimate of 4000 p.s.i. due to column shortening would be realized by the completion of the building early in 1958. Therefore, the bracing bar stress under zero wind force would be 12,000 p.s.i. and under maximum wind the bars would be stressed to 22,000 and 2000 p.s.i. tension respectively.

Fig. 12. Welding the final connection.

Fig. 13. Checking stress with extensometer.

The method of making the bottom connection of the bracing bar was closely followed with extensometer readings. After several uses of a high-strength bolt, the effectiveness of the bolt in holding the stress in the bar began to decrease. It was decided to replace the bolts after the second use and use a constant torque for all bolts. This eliminated the loss in stress previously observed. The procedure for making the welded connection required a tack-weld at the toe of the jaw plate before the regular upward weld pass was made. This would display any possible slippage that might have been caused by weld heating.

Conclusion

The problem of overcoming wind forces in the tall Queen Elizabeth Hotel building was overcome by the use of a system of flat plate bracing bars with a dual purpose. Its first use was as temporary erection bracing and secondly, after pretensioning, as permanent bracing enclosed in a narrow 6 in. partition.

The pretensioning operation was carried out by heating the bracing bar, clamping the free end and welding the final connection. This was carefully checked by extensometer readings to ensure a tension which would never allow the bracing bar to go into compression under the maximum wind load. Consequently, the bracing bar could be enclosed in a narrow space without any fear of buckling and consequent cracking of partitions.

Fig. 14. View of hotel on completion of pretensioning.

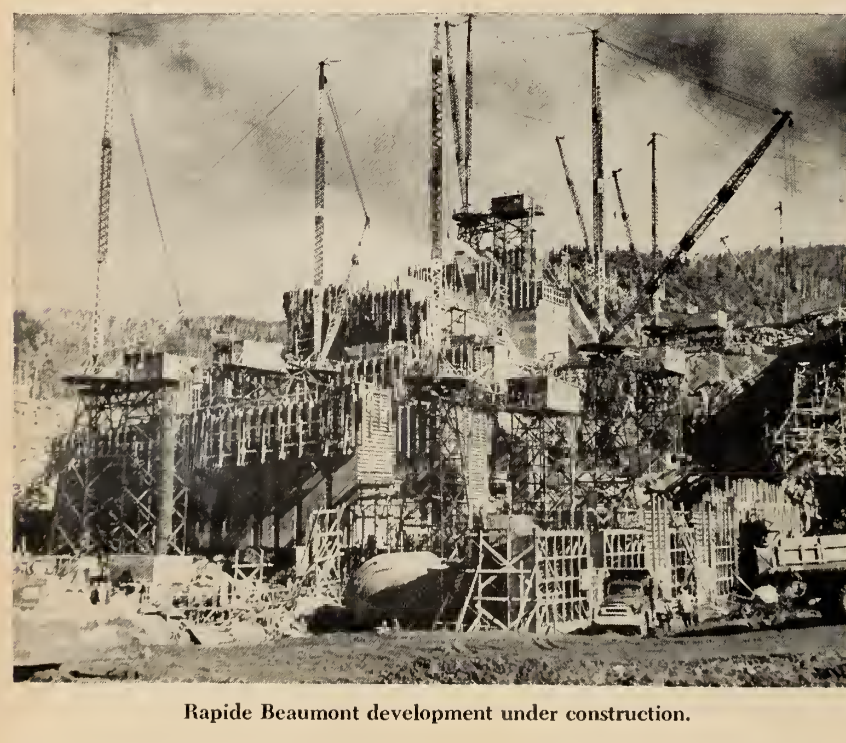
Acknowledgments

The Queen Elizabeth Hotel was designed by the architectural and engineering departments of the Canadian National Railways. Associate architects were Holabird Root and Burgee. The Conrad Hilton Hotel Company will operate the hotel on behalf of the Canadian National Railways. The steelwork was designed, fabricated and erected by Dominion Bridge Company Limited under contract with the Canadian National Railways.

Shawinigan's Rapide Beaumont Development

At Rapide Beaumont, on the upper St. Maurice River, near La Tuque, Que., The Shawinigan Water and Power Company has under construction a hydro-electric power project which will add 246,200 kilowatts to the capacity of the Shawinigan system, at a total estimated cost of $56.5 million. Design and construction is being done by The Shawinigan Engineering Company Limited.

The gross head available for producing power will be 125 feet. The dam will extend 1,600 feet from bank to bank. It will contain the intakes through which the water will pass to the "semi-open"-type power-house below, sluiceways to accommodate peak flow of water during flood periods, regulating gate section, and log chute.



Rapide Beaumont development under construction.

There will be six generating units. The turbines are the single-runner, verticle, Francis type, rated at 55,000 horsepower each, for a total of 330,000 horsepower. They are directly coupled to 45,000-kva., 13,800-volt, 60-cycle, 3-phase, totally enclosed, water cooled generators. Power will be fed through air-blast breakers to individual 45,000-kva. transformers which will deliver the power at 230,000 volts to a single bus, from which the whole output will be delivered to the transmission line through a single 230,000 volt air-blast breaker.

In order to construct the dam, the flow of the river had to be diverted through a by-pass channel 1,000 feet long, 130 feet wide, and 100 feet deep. The development necessitates removal, in all, of approximately 10 million tons of earth and rock.

The project is scheduled to start delivery of power in November, 1958, with all units in service by the spring of 1959.

The Queen Elizabeth Hotel — Outline of Electrical and Mechanical Services

N. S. B. Watson, M.E.I.C., *Electrical and Mechanical Engineer*

N. A. Klodniski, M.E.I.C., *Asst. Electrical and Mechanical Engineer*

Office of the Chief Architect, Canadian National Railways

THE FOLLOWING description of electrical and mechanical services is a brief outline, presented at this time in an effort to provide a complete presentation of the major engineering aspects under one cover. A more thorough presentation, of special interest to engineers actively engaged in this branch of engineering design will appear in a later issue.

General Description

The Queen Elizabeth Hotel has in general been designed and laid out to include the latest proven equipment and service distribution practice, with special attention in engineering application to provide the additional features and reliability and flexibility required in a convention hotel operation.

The existing site, adjacent to the Central Station, with train operations below and levels already established, especially on the lower floors, presented many design and layout problems.

Electrical Supply

The main transformer vault located at track level adjacent to the Mansfield Street retaining wall is supplied from two Quebec-Hydro sub-stations by means of two underground cables at 12,000 volts, 3 phase, 60 cycles.

Two 1000 kva, 3 phase, transformers provide 120/208 volt, 3 phase, four wire service for general lighting and kitchen and laundry power. Six 750 kva, 3 phase, transformers provide 575 volt, 3 phase, 3 wire service for general power, as well as lighting in remote areas by means of secondary step down transformers. The eight transformers are arranged in two rows to form two identical and separate groups each supplying one half of the hotel building load and each normally fed by one of the incoming cables.

Primary switchgear provides for automatic transfer of load to the serviceable cable, in the event of failure of one incoming cable, and secondary switchgear is arranged to permit manual transfer of load from one group of transformers to the other in the event of failure of any transformer.

This is an outline of the electrical and mechanical services that are to be installed in the Queen Elizabeth Hotel. A more complete engineering paper will appear later.

An auxiliary power supply, consisting of a 500 kva, steam turbine driven alternator, located at track level adjacent to Mansfield Street, provides 575 volt, 3 phase, 3 wire, 60 cycle service for emergency lighting throughout the building public rooms and corridors and emergency power service for two elevators and miscellaneous essential equipment.

Electrical Distribution

The comparatively large transformer sizes and the extent of the building required that more than normal consideration be given to rupturing capacity, distribution voltages and voltage regulation in the design of the distribution system and associated gear.

Lighting distribution in the lower levels, up to and including the third floor, is 120/208 volts, 3 phase, 4 wire and radiates from a main switchboard located on the hotel service floor, two stories below street level. The switchboard is fed directly from the two 1000 kva transformers by means of totally enclosed bus and is made up of high rupturing capacity air circuit breakers which feed radially via conduit and wire feeders to lighting break - down panels equipped with high rupturing capacity fuses. The lighting break-down panels are located at main load centers and in turn feed radially by means of bus duct or conduit and wire feeders to standard circuit breaker type lighting panels.

Lighting distribution for the upper floors, 4th to 21st inclusive, is provided by means of four 150 kva. banks of secondary transformers, 575 volts to 120/208 volts, located in penthouses above the 21st floor to be remote from guest bedrooms.

The secondary lighting distribution transformers are fed directly by means of conduit and wire feeders from a main auxiliary switchboard located on the hotel service floor.

Each secondary lighting transformer bank feeds a main distribution panel made up of standard rupturing capacity type fused disconnect switches which, in turn, feed vertically down to lighting break-down panels located on every fifth floor. The lighting break-down panels are also of the standard rupturing capacity fused disconnect switch type and feed, up and down, to standard circuit breaker type lighting panels.

Power distribution for heating, ventilation, air-conditioning, plumbing, fire protection, elevators, etc., is 575 volts, 3 phase, 3 wire and radiates from a main switchboard located on the hotel service floor. The switchboard is fed directly from the six 750 kva. transformers, by means of conduit and wire feeders, and is made up of high rupturing capacity air circuit breakers which feed radially to power break-down panels and thence to standard circuit breaker type power panels in a manner similar to the lighting distribution.

Power distribution for laundry and kitchen equipment is 120/208 volt, 3 phase, 4 wire and is also distributed radially from the main 120/-208 volt switchboard.

An auxiliary 575 volt switchboard, located adjacent to the main switchboards on the hotel service floor, provides automatic and manual switching facilities as required to adjust turbo-alternator load and as required to provide emergency lighting and power service.

Auxiliary power is distributed directly at 575 volts and emergency lighting is provided by means of single phase secondary step down transformers located strategically throughout the building.

Lighting

Lighting fixtures of all types, incandescent and fluorescent, are utilized as required to provide design requirements.

Service areas, such as the mechanical room, are lighted by means of prismatic glass reflectors to provide sufficient upward component of light for good visibility of piping, valves, etc.

Storage areas are lighted by means of standard incandescent or fluorescent lighting units, depending on intensity of illumination required.

Kitchens are illuminated with colour corrected fluorescent units to provide a reasonably high level of lighting with good colour rendition.

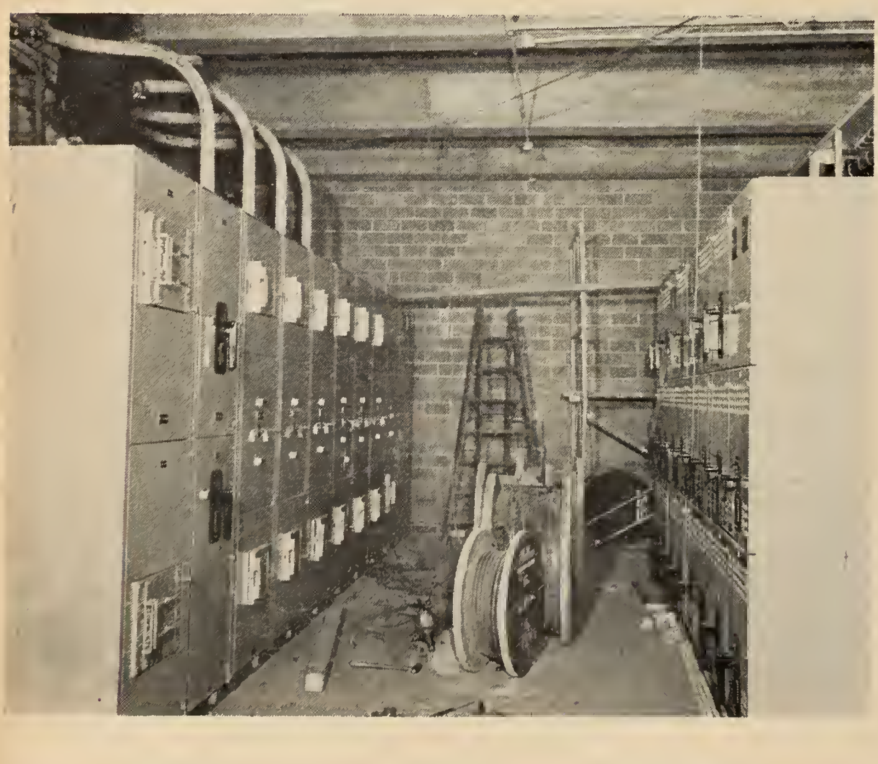
Standard fluorescent lighting units are used to provide the high lighting levels demanded in office areas.

Banquet and dining areas are illuminated by means of various combinations of incandescent recessed units, chandeliers, indirect lighting coves equipped with three colour cold cathode fluorescent tubing, with illuminated wall panels, murals and windows as decoration demanded.

Fluorescent panels provide general lighting in exhibit areas and incandescent units with special lamps, reflectors, lenses and apertures are used to provide accurately controlled lighting for illuminating displays.

The main banquet rooms and the main dining room, which is to be used as a supper club, are completely equipped with stage lighting facilities. Dimmer switchboards provide complete control of general lighting, as well as stage lighting. All other public rooms are equipped with dimmers to provide the flexibility required in the presetting of lighting to suit the various convention functions.

Fig. 1. Secondary switchroom under construction, showing 575 v. auxiliary switchboard, left, and main 575 v. switchboard, right.



Guest bedroom lighting is provided by means of table lamps and floor lamps designed to match bedroom furniture.

Guest bedroom bathrooms are equipped with special electric razor receptacles designed to eliminate the hazard of accidental electric shock due to contact with plumbing fixtures.

Emergency lighting is provided in all public rooms and corridors etc. by connecting specific units of those used to provide normal illumination to the auxiliary lighting supply source. Thus the auxiliary power supply constantly provides part of the normal illumination and on a failure of the main power supply the emergency lighting remains on. Where emergency lighting units are dimmed together with all lighting units, manual or automatic, over-riding switches are provided on the auxiliary lighting circuits as required.

Television and Audio

Each guest bedroom is equipped with a combination television and audio receiving set and outlets are provided in all public rooms for sets as they may be required. Each set is equipped to provide a choice of six T.V. channels and six audio programs. In addition, each set is equipped with an emergency "All-Call" paging feature which is operative regardless of whether set is turned "on" or "off".

Distribution, by means of a coaxial cable for T.V., with audio pairs wrapped around, is arranged vertically for economy and radiates from a central control room located on the third floor.

Control equipment, rack mounted, provides for the direct reception of eight T.V. channels and six radio programs, and in addition, one closed circuit T.V. program originating at the site or incoming via cable, two audio programs originating at the site or incoming via cable and two local tape recorded programs.

Input and output switching and monitoring equipment, designed for easy operation, provides complete flexibility in the selection and transmission of program material.

Program Sound Distribution

All public rooms such as banquet rooms, main dining room, private dining rooms, etc., are equipped to provide sound pick-up and local sound reinforcement in each room and loudspeakers are designed to operate at low level to provide ready hearing in all corners without discomfort.

Microphone and loudspeaker feeders from each public room are run individually and directly to the common central control room serving the television system but are terminated on separate equipment racks.

Control equipment is designed to provide the utmost in flexibility such that sound originating in any room may be amplified and returned to the same room or distributed to any or all rooms.

Control equipment provides, in addition, for the recording, reproduction and distribution of tape recorded program material from and to any public room or outside private lines, provides convention paging facilities in main public lobbies, provides emergency "All-Call" source equipment which serves the guest bedroom system, in addition to all public rooms, and provides for the distribution of recorded music to such areas as laundry, work shops, etc.

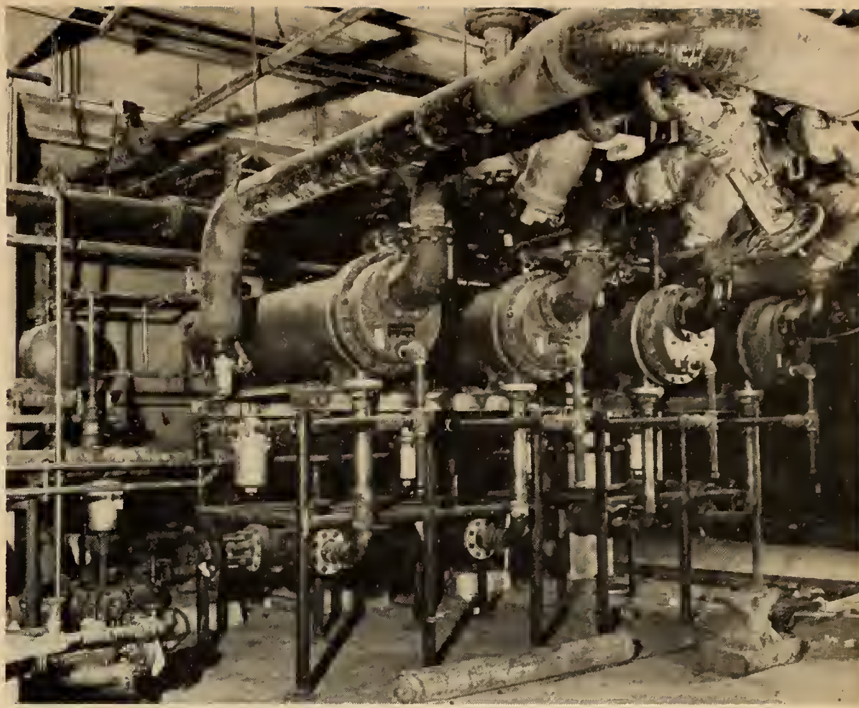


Fig. 2 Section of main service floor, showing semi-instantaneous hot water heaters before application of insulation.

Fire Alarm System

The fire alarm system is a complete system, consisting of manual fire alarm stations located strategically throughout the building, fire detectors located in areas such as linen rooms, sprinkler alarm devices and supervisory valves, together with watchman's tour stations, and all are connected to a central control location on the hotel service floor.

Single stroke gongs sound a coded alarm at suitable locations to enable hotel fire fighting personnel to respond to same without undue alarm to guests. Such coded alarms are, in addition, recorded in the front office and in the engineer's office on punch registers.

General evacuation continuously ringing alarm bells, located adjacent to each manual fire alarm station, may be sounded individually, for local evacuation, by means of local switches or in blocks, for general evacuation, by means of switches located in the front office and in the engineer's office. General evacuation alarm bells are to be sounded and fire alarm signal is to be transmitted to the city fire department at the discretion of the hotel fire fighting personnel on investigation.

Provision for watchman's tour consists of an arrangement of preliminary and transmitter stations located throughout the building in such a manner that the watchman must report at each station in a fixed sequence. The operation of a transmitter station by the watchman causes the aforementioned punch registers to record time and a coded signal but no signal is sounded on single stroke gongs.

Fire alarm annunciators are provided as additional aids in the rapid location of operating sprinkler sections and fire detectors.

The entire system is a closed circuit type, the circuits and apparatus being electrically supervised to sound a local trouble alarm and, in addition, to transmit the same alarm to a commercial supervisory service which would respond in the event of a delinquency.

General Alarm System

To avoid confusion, due to multiplicity of alarms, all other events requiring attention, such as transformer high temperature, low air pressure, boiler low water, water pump failure, etc., are indicated on a station type annunciator equipped with a common red alarm light and common alarm horns. Alarm horns are sounded within the working area of supervisory personnel and may be silenced immediately but red alarm light remains illuminated until alarm initiating device automatically restores the previously silenced horn to ready state.

An electrically operated, self-regulating, 24 volt, d-c minute impulse clock system is provided to control public room decorative clocks, standard secondary clocks in laundry, kitchens, work shops, offices, etc., and attendance time recorders.

Control is provided by means of a master clock and associated mechanism which provides individual hourly supervision and correction to all secondary clocks.

Telautograph System

Communication between such points within the hotel as the telephone room, front office, housekeeper, bell captain, valet and engineer requires rapid transmission of messages simultaneously to more than one point together with a written record. The telautograph system provided is electrically operated with transmitter and receiver stations connected by wire conductors such that messages are transmitted to the desired receiving stations and reception is a facsimile of the senders' handwriting on a continuous paper roll.

Telephone System

A central automatic exchange, together with an eight position switchboard, are located centrally on the third floor.

All instruments are dial type, using standard letters and numerals on the outside of the dial with the most often required hotel service departments indicated under the dial.

The guest may thus call any one of the most commonly required service departments directly by dialing one digit and may make local outside calls directly by dialing, without contacting the operator. Long distance calls are made directly to the Bell Telephone Company toll operator.

Outgoing local calls are metered on a register located in the front office in the billing section and long distance charges are forwarded directly from the Bell Telephone Company to the front office by teletype. All incoming calls and room to room calls are made through the operators to avoid inconvenience to guests.

Telephone instruments are also equipped with a signal light, controlled by the operator, to indicate to the guest that there was a message left for him during his absence.

Fig. 3. View of largest of banquet rooms under construction, showing installation of standard low-pressure air conditioning ducts.

Fig. 4. View of corridor to private dining rooms, showing specific example of crowding of ductwork in certain areas to maintain headroom.

Heating and Air Conditioning

Steam for building heating, ventilating, air conditioning, water heating, kitchen, laundry, and for the turbo-generator is supplied at 375 p.s.i.g. and 500° F. from the C.N.R. Nazareth Street boiler plant approximately ¾ of a mile away, through lines carried in a pipe tunnel.

The steam pressure is reduced on entering the hotel building to 15 p.s.i.g. for heating and to various intermediate pressures for use in the kitchens and laundry. 375 p.s.i.g. steam is supplied to the turbo-generator which has a capacity of 500 kva. and uses up to approximately 20,000 lb. of steam per hour on full load, which is exhausted into the low pressure steam header at 15 p.s.i.g. and is then used for general heating purposes. The quantity of steam exhausted can be controlled by adjusting the electrical load on the turbo-generator. Should the turbo-generator exhaust more steam than can be used, the excess is discharged through a back pressure valve above the roof of the building. Should there be demand for more steam than the turbo-generator is exhausting, pressure reducing valves feed the additional requirements from the 375 p.s.i.g. line. A small amount of steam may also be fed into the low pressure system from a small boiler which was installed for burning solid refuse, such as cartons, crates, etc. No garbage will be incinerated on the premises.

The heating for most of the building is done by means of the ventilating and air conditioning systems. However, there are two forced flow hot water heating systems, one which serves each guest bathroom and one which serves direct radiation along outside walls in the public areas of the hotel. Forced flow steam heating units are installed at entrances, and steam unit heaters are installed in equipment rooms and storage areas.

With the exception of the kitchens, laundry, and certain service and storage areas, the building is fully air conditioned. The air conditioning is divided into two main types, a high pressure system for the bedroom section and a number of low pressure conventional systems for public areas, such as dining-rooms, banquet rooms, bars, cocktail lounges, exhibit rooms, etc.

The bedroom high pressure air conditioning system consists of four air supply units located in penthouses above the twenty-first floor, which supply a total of approximately 80,000 c.f.m. of cooled and dehumidified, or heated and humidified outside air, to four zones of under-window supply units. Cooled or heated water is also supplied to the under-window units from two zone convertors located in the penthouses. Room temperature is controlled by the guest with a room thermostat, which operates an automatic valve on the water supply to each air conditioning unit. In this type of system, both cold water and cold air are used for maximum cooling, and warm air and warm water are used for maximum heating. During in-between seasons cool air and warm water may be used to permit either heating or cooling of any room independently of any other room. The air conditioning units installed in the rooms are of the induction type, the cooled or heated air being supplied through nozzles which induce a flow of room air through the units, without the use of fans and motors in the units. Each standard bedroom is supplied with 50 c.f.m. of conditioned air, and 50 c.f.m. of air is exhausted from the bathrooms to keep the system in balance.

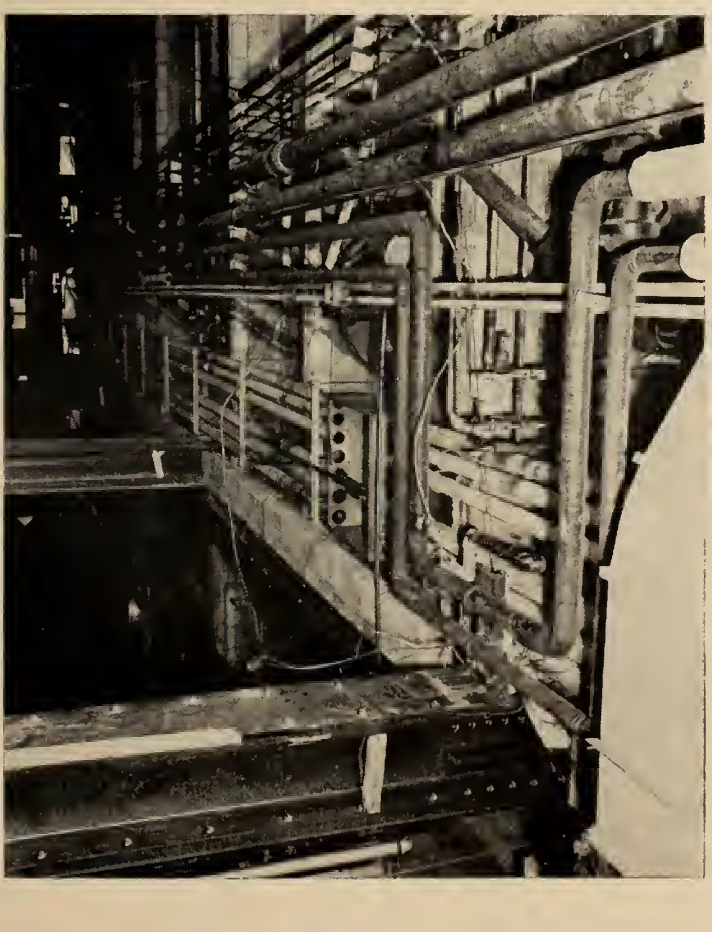
As previously stated, the air conditioning of the public areas in the lower floors of the hotel consists of conventional low pressure systems. There are 30 of these systems handling a total of approximately 210,000 c.f.m., equipment for which is located in 4 fan rooms.

This number of separate systems permits air conditioning only in those rooms which are in use at a given time and also permits separate control of conditions in various rooms. Rooms such as shops which are used on regular hours are served by large zoning units which permit separate control for each room according to load. Air is distributed by conventional low pressure ductwork and supplied to the rooms by diffusers and grilles.

Both the bedroom air conditioning system and the public space systems use chilled water as a cooling medium. This chilled water is supplied from a central refrigeration system consisting of two centrifugal compressors, one 300 hp. and one 800 hp. capacity, located in a sub-basement room. Either compressor may be run alone or both may be run together. Starting and stopping of the compressors is manual, but once running, their capacity is automatically controlled. Condensing water for the compressors is supplied from a three fan cooling tower located on top of the building.

All areas of the hotel which are not air conditioned are ventilated by a conventional ventilating system including the taxi areas at the entrances to the hotel and to Central Station. The ventilating systems for the laundry, kitchen, storage areas, equipment rooms, taxi areas, etc., involve a total of 10 large supply fans and 20 exhaust fans, the largest of which is the taxi entrance unit which handles 60,000 c.f.m.

Fig. 5. Typical view of horizontal distribution piping and conduit on a lower level floor before ceiling installation.



Supervisory Data Center

A supervisory data center has been installed to supervise and facilitate the operation of the heating and air conditioning systems. This data center is located facing the main corridor between the Central Station concourse and the hotel elevators behind a long wall of glass in full view of the public.

A colour graphic control panel 22 ft. by 4 ft. provides graphic representation in a functional way to the 35 air handling systems by incorporating a complete schematic layout of the fan systems showing dampers, heating and cooling coils, fan motors, etc.

Each system is provided also with a control point adjustment knob to adjust the final control point, with start-stop push button stations and pilot lights for central control of 82 fan motors and with temperature check points which are also recorded on an electric typewriter.

An automatic data handling feature incorporated in the supervisory data center will scan and record temperatures automatically at regular intervals, and will provide audible and visual alarm in the event any critical temperature check point varies from preselected limits. Any temperature variation beyond the tolerable limit is permanently recorded in red ink. Steam and water flows are totalized by means of desk mounted counters.

Remote adjustment of temperatures in public rooms is accomplished by means of electronic thermostats located in the public rooms, whose control point is adjusted from the colourgraphic panel.

Plumbing

Domestic water supply is normally provided by means of an 8 inch City water main from Mansfield Street and an additional 8 inch water main is provided from the Central Station. Meter and valve arrangements provide for the transfer of water flow between the hotel and station water supplies in the event of an emergency.

The domestic water distribution system is divided into high level, intermediate level and low level zones.

The low level zone, serving all floors below the third floor, including kitchens and laundry, is supplied directly at city main pressure.

The high level zone, serving all floors above the 10th floor, is supplied by means of booster pumps located on the hotel service floor and by means of house tanks located over the 21st floor.

The intermediate level system is supplied from the high level system by means of pressure reducing valves.

Four domestic water supply booster pumps, 200 U.S. g.p.m. each, located on the hotel service floor, operate automatically and in sequence to maintain water level in the house tanks under varying water demand rates.

Four house tanks, 10,000 U.S. gallons each, located in a penthouse, serve to even out peak water demand requirements and provide reserve emergency supply.

Hot water for guest bedrooms is provided by means of four semi-instantaneous hot water heaters each capable of heating 7,800 U.S. g.p.h. from 40°-140° F. with 10 p.s.i.g. steam.

Hot water for lower level public rooms, kitchens and laundry is obtained by means of three storage heaters providing 140° F water for lower level public rooms and kitchens and 180° F water for the laundry, booster heaters being provided for dishwashing. Each storage heater has a capacity of 5,000 U.S. g.p.h., the laundry storage heater being served with an economizer capable of heating 3,000 g.p.h. from 50° to 105° F when supplied with 4,400 g.p.h. of 120° F waste water.

Chilled drinking water is supplied to all guest bedrooms, distribution being divided into two zones.

Fire Protection

Fire protection is provided by means of a high level system of standpipes serving all bedrooms above the second floor and by means of a low level system of sprinklers and standpipes serving the lower floors.

The system distribution piping is entirely separate from the domestic water distribution and is served by means of a six inch high pressure City water main provided exclusively for fire protection purposes.

Three booster fire pumps, each of 500 U.S. g.p.m. capacity, and a booster jockey pump are connected and valved such that the two systems are normally served from the high pressure fire main and additional capacity, if required, is provided from the domestic water service. The entire operation is fully automatic with standard provisions for manual operation, as required.

Fire hose cabinets are equipped with 1½-in. hose terminated with adjustable "stream-fog-shut off" type nozzles and with standard 2½-in. hose valves for Fire Department use.

Sprinklers, in general, are provided in all storage areas and extra hazardous locations and are of the standard "wet pipe" or "dry pipe" type.

Laundry

The laundry is located one floor below street level and is of unusually large capacity as it is designed to take care of railway and steamship work originating in this area, in addition to hotel requirements. All possible machinery is of the automatic type, including self-unloading washers and automatically timed extractors.

Linen is transferred from the upper floors by means of chutes to the main sorting room, where after preliminary sorting it is transferred by a conveyor system to a mezzanine floor where the final sorting is done into hoppers, each of which holds the exact amount of linen required to fill one section of a washer. The transfer of linen from hoppers to washers takes place by gravity when the bottom doors of the hoppers are opened.

Conveyors are also extensively used for transferring wet linen to conditioning tumblers and flat work ironers.

The hotel guest laundry is done in a section of the room distinct from the regular hotel and railway work and is self-contained as to washers, extractors, shirt presses etc.

Vacuum Cleaning

A central vacuum cleaning system is provided and sweeper outlets are installed on all bedroom floors as well as in all public areas. These outlets are all piped to a central vacuum producing machine located on the main service floor. Sweepings from the various floors are collected in a large dust separator adjacent to the vacuum producer and from which they can be removed and disposed of along with other refuse from the building.

Pneumatic Tube Conveyor System

A pneumatic tube conveyor system is provided between a central dispatching and receiving station, located in the front office, and cashiers in all dining areas, in order that meal cheques signed by guests may be transferred to the billing clerk with a minimum of delay.

The Central Station is also connected to the engineer's office as well as to all service areas such as telephone switchboard, laundry, valet shops, etc.

The tubing through which pass the carriers containing guests' cheques, written messages, or anything that can be placed in a carrier, is made of steel 2¼ in. in diameter. All terminal stations are equipped with pilot lights to signal the arrival of a carrier at the terminal.

Kitchen Equipment

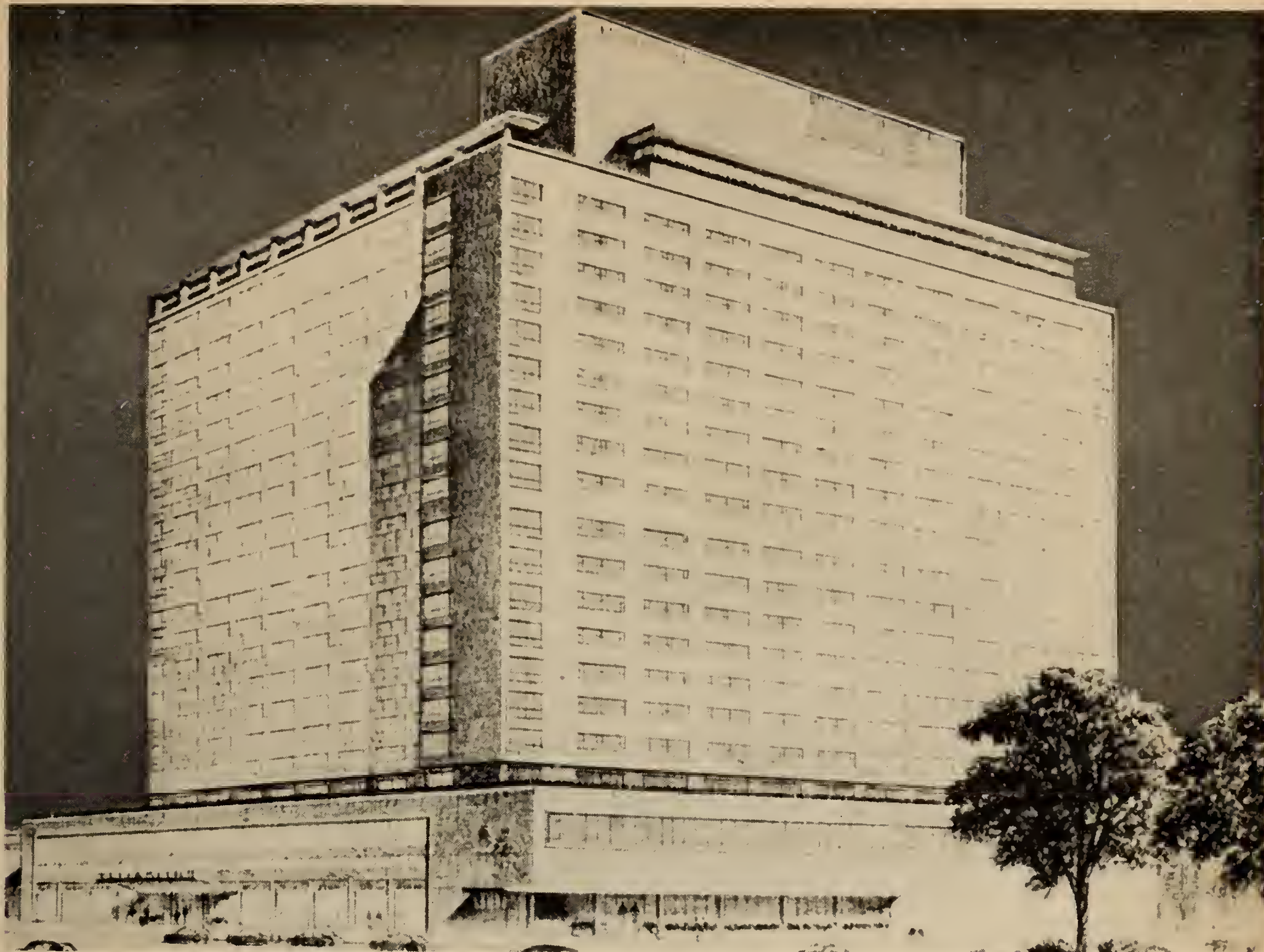
There are five kitchens in the hotel. The main kitchen, located on the main floor; banquet service kitchen, located on the second or convention floor; a small kitchen located on the 21st floor, to serve the function rooms and cocktail lounge, located on this level; a staff kitchen, located two floors below street level; a separate kitchen also is provided for the restaurant serving the Central Station.

All of the kitchens are fully equipped with the most modern equipment. All fabricated pieces such as steam tables, kettles, work surfaces, sinks, refrigerators and exhaust hoods as well as all trims on ovens and machines are stainless steel throughout. Cooking is, in general, done with gas and steam, some smaller units are electric.

Dishwashing is centralized in an area on the lower level for all areas served from the main kitchen and staff kitchen, the soiled dishes being carried to the area by horizontal and vertical conveyors. The dishwashing machines are of the latest continuous conveyor type.

The banquet service, station level, and 21st floor kitchens are equipped

(Continued on page 1824)



A General Description of the Queen Elizabeth Hotel

THE QUEEN ELIZABETH HOTEL, Montreal, is scheduled to open in the spring of 1958.

Twenty-one stories high, with 1,216 guest rooms, the hotel is the first in the world to provide centralized electronic heating and air-conditioning control, and individual dial telephone service from guest rooms. The hotel's picture windows overlook the heavily-treed slopes of Mount Royal immediately to the north and the St. Lawrence River to the south. The hotel's frontage on Montreal's widest thoroughfare, Dorchester Street, together with its height above surrounding buildings, affords the advantage of an excellent view of the city.

A Convention Hotel

Created especially for conventions, the $20,000,000 hotel combines the facilities needed for the efficient handling of meetings of many types and sizes, from marketing sessions with the emphasis on staging, timing, etc., to small, intimate meetings in the quiet atmosphere of an executive suite.

As important as the physical equipment is the convention planning. Co-ordination of hotel services with the requirements of the agenda is vested in an hotel officer who works directly with the convention group's committee or local representative. This officer chairs the hotel planning board that brings together all departmental heads concerned with the details which ensure smoothly operated conventions, and his job ends only when the last delegate has left.

The convention floor is very convenient, being only one storey above ground level, is reached quickly by both escalator and staircase and served by its own kitchens and food storage. The Ballroom (Le Grand Salon) measures 98 x 70 ft. with a stage 14 x 46 ft. and the necessary hanging gallery for spotlights. It will accommodate nearly 800 people for dining or 1000 for meetings. Soundproof disappearing doors will form two walls between ballrooms 1, 2, and 3, and when used as a single unit, there will be accommodation for up to 2000 people for dining or 3000 for meetings. Special banquet rooms (named after famous explorers of Canada) and eleven private dining rooms (named after Quebec rivers) are avail-

Le Grand Salon

View of front of the hotel, looking south on Mansfield Street.

able on this floor for private meal gatherings, business meetings, convention groups or sales conferences. Through the use of soundproof disappearing walls between some of the private dining rooms, the complete space of two or more rooms will be available, providing accommodation for up to 350 persons for dining and 400 for a meeting. There is 15,000 square feet of exhibit space, an automobile hoist and radio and television projection rooms.

The sample room floor is immediately above the convention floor, and buyers and sellers can come together in a welcome economy of time and space. This floor has 23 large sample rooms with shelf and lighting fixtures, 34 traditional bedrooms and two suites.

Main Lobby

Native Canadian wood and stone are used in the main lobby which is spacious, comfortable and dignified. A frieze which recalls ancient Quebec handicrafts, and floor coverings reminiscent of the hooked rug patterns of the Norman and Breton pioneers are a fitting introduction to the Province of Quebec. The broad open registration desk is centrally located and designed to check guests in speedily.

Dining Rooms

The Louis XVI dining room on the main floor (Salle Bonaventure) has lofty ceilings, deep-pile carpets, classical ornamentation and mirrored walls.

For less formal dining occasions the adjoining Beaver Club adopts an atmosphere of cheerful cosiness. The Club has a companion room, Les Voyageurs, its cocktail lounge.

The Coffee House, also on the main floor, is an informal dining spot where service will be paced to the needs of the customer whether it is a snack or a full-course meal.

Lookout

Visitors to Montreal are drawn to the lookout high up on Mount Royal. The Queen Elizabeth has its own lookout on the 21st floor, a cocktail lounge named Le Panorma for its view of midtown Montreal and the St. Lawrence River. At night the neon-flecked ribbons of light in the close-packed downtown area fade off into the Quebec countryside. Le Panorama has a tremendous sweep of window, a transparent wall 200 feet long, and a large attractive fireplace.

Guest Rooms

In its guest rooms the Queen Elizabeth has a combination of the traditional and modern. Studio bedrooms afford a sitting room by day and bedroom by night. The box spring, mattress and headboard are also provided for guests who prefer them.

All bedrooms are outside rooms; each room has a combination radio-television receiver, and a wide picture window which reaches from wall to wall. Drapes, floor coverings and upholstery harmonize, and nicely-balanced furniture groupings are possible because there are no small rooms in the Queen Elizabeth, a square-plan structure. Each guest room has its own control for heating, cooling and air-conditioning. Individual dial telephone service from guest rooms will permit direct calls; a light on the phone will notify guests returning to rooms that a call was received in their absence, and the switchboard will give details. While a window panel will open, it is a gesture only to cherished custom.

Suites on every floor provide extra accommodation for the long-stay guest and those who plan in-hotel entertaining, and special pains have been taken to give each suite a character peculiar to it alone.

Lower Lobby Entrance

One of the innovations which should be appreciated is the consideration given to the guest arriving by automobile; he drives right to the lower lobby entrance, his car is unloaded and parked immediately in the adjacent autopark, only feet away; he registers at the lower lobby desk and is roomed directly from it. The barber shop, valet, laundry, shoeshine and shops are on the lower level floor.

Central Station Entrance

Central Station concourse is directly connected by escalator and elevator to the main lobby of the Queen Elizabeth, thus the lines of Canadian National Railways with their North American connections lead directly from train to hotel.

Airlines Terminal Entrance

The Montreal airlines terminal is located in the adjoining building and reached through the station lobby, another convenience to the traveller.

Conclusion

The Queen Elizabeth will be the newest hotel in Canada, and will be operated by the Hilton Hotel organization. It will be an interesting addition to the city and will increase, considerably, Montreal's convention facilities.

Aerial view of the hotel looking south; in foreground and background are railway leading to and from Central Station.

Le Panorama

The Oak Street and Middle Arm Bridges

L. Osipov

Chief Designing Engineer,

Phillips, Barratt and Partners, Vancouver, B.C.

THE OAK STREET and Middle Arm bridges, built by the British Columbia Toll Highways and Bridges Authority, replace the old Marpole swing span which has served as a bridge crossing over the North Arm of the Fraser River since the turn of the century. The new bridges will provide a four lane outlet from Vancouver at the foot of Oak Street, southward to Lulu Island, Delta municipality, the Fraser valley and the United States, as well as a two-lane crossing from Lulu Island to Vancouver's international airport on Sea Island.

The need for a new bridge was forcefully demonstrated for a number of years prior to the decision to build a new span. Since the old swing bridge, a narrow two lane structure, provided only ten feet of clearance over mean high water, almost every craft passing up or down the river had to call for the opening of the span. It was estimated that an average of about 8,000 openings occurred each year, not to mention the number of times the old bridge was out of operation due to collisions from boats which drifted against the centre and flanking piers. This condition, combined with morning and evening rush hour bridge traffic, growing industrial expansion along the Fraser River, racing at Lansdowne Park, or special functions at the Vancouver airport, led to repeated traffic congestion in this vital area.

Traffic has long been seriously restricted between Vancouver and Lulu Island, to the south, and Sea Island, on which the international airport is situated, because of limited bridge capacity across the Fraser River. This paper describes the features of the new Oak Street and Middle Arm Bridges, which were opened in the summer of 1957. Above is a view of the Oak Street bridge continuous plate girder. The longest of its kind in Canada (710 ft.), the centre span is 300 ft. long.

After lengthy negotiations with the City of Vancouver and the Federal Government, the Province decided to assume responsibility for the project. On October 8, 1953, under the authority of the Minister of Public Works of B.C., the Honourable P. A. Gaglardi, the firm of Phillips, Barratt and Partners, consulting engineers, was commissioned to obtain a reasonably accurate estimate of the cost of a new highway crossing over the North Arm of the Fraser River. This estimate was to be based on the most economical solution which would provide uninterrupted traffic flow over the North Arm of the river, proper navigational clearances and adequate connections to streets and roads.

After a number of studies which gave consideration to five possible locations, it was agreed that the high level crossing should begin at the foot of Oak Street and run southward to Lulu Island on a line parallel to and 270 ft. east of, the existing B.C. Electric Railway bridge. This was considered the most desirable location for the following reasons:

(1) Only a 60 ft. vertical clearance over mean high water was required at this site.

(2) The height of the bridge here would not be a hazard to aerial navigation.

(3) The proposed turning basin for shipping west of the B.C. Electric Railway Bridge would be left open.

(4) The present traffic bottleneck at Marpole would be eliminated.

(5) Oak Street was being improved by the City of Vancouver and would become the most convenient artery to take traffic from Vancouver to western Lulu Island and the airport.

(6) This location would tie in with the new Trans-Canada highway connection across the Fraser River downstream from New Westminster.

(7) Property acquisition costs would not be too heavy here.

(8) The location would provide no hazard to river navigation.

Confirmation that four lanes would be sufficient to carry the anticipated traffic from Vancouver to Lulu Island was obtained from the City of Vancouver Traffic Department, which estimated that by 1971, the peak commuter traffic would be 3340 vehicles per hour over the existing Fraser Street bridge and the new Oak Street bridge. At the rate of 1400 vehicles per lane per hour, three lanes would therefore be ample for these requirements. Since one lane was provided by the Fraser Street bridge, two lanes each way appeared to be sufficient at Oak Street. The consulting engineers recommended that when overload peaks were reached, the old Fraser Street bridge should be replaced and that area developed into another main artery for southbound city traffic. Such a development, it was generally agreed, would be more desirable than trying to funnel all traffic into one city area.

Fig. 1. Key plan showing location of Oak Street and Middle Arm bridges, which provide a four-lane outlet from Vancouver at the foot of Oak Street, southward to Lulu Island and the United States, and a two-lane crossing from Lulu Island to Vancouver's international airport on Sea Island.

The low-level two-lane Middle Arm crossing did not readily satisfy all the interested parties. The Airport Board expressed a preference for a four lane high level bridge. However, the greatly increased cost of such a scheme was difficult to defend, since only about one opening of the bridge per day would be required and one lane each way was more than ample for the anticipated traffic to the Airport.

General Bridge Features

The following are some of the main features of the Oak Street bridge. The north end consists of approximately 1900 ft. of four lane approach spans beginning at the foot of Oak Street and passing over Marine Drive and several adjacent railway tracks. A grade of 2 per cent was sufficient to provide adequate clearance over the tracks and Marine Drive. North-bound traffic which intends to come down on Marine Drive and head eastward will be able to utilize a 550 ft. long single lane ramp diversion provided for that purpose. In general, the north approaches consist of four continuous 60 ft. span units of reinforced concrete supported on twin-shafted reinforced concrete piers with spread footings on glacial till or on steel piles driven to till near the river shore.

The four lane south approaches are over 3000 ft. long, passing over a CNR right-of-way, Beckwith and Bridgeport roads, and connecting with a future highway system on Lulu Island. In addition, there is a 550 ft. long two lane diversion for southbound traffic toward the Middle Arm crossing and Sea Island.

The bridge toll booths will be located at the ends of the south approaches. As in the case of the north end, a 2 per cent grade was selected, giving adequate clearance over railway and roads. The superstructure and piers are similar to the north approaches except that the piers on Lulu Island are founded on untreated timber friction piles driven approximately 35 ft. into a very deep layer of sedimentary sand which overlies the glacial till in this region.

The portion of the bridge over the Fraser River is divided into two sections of different design, both four lanes in width. The southerly 600 ft. consists of five 120 ft. simple spans of composite concrete slab and welded steel girders. The girders, built up from plates, are 8 ft. 6 in. on centres, 7 ft. 0 in. deep, and are supported by reinforced concrete piers founded on steel piles driven to glacial till. The northerly 706 ft. consists of a reinforced concrete deck supported by two continuous riveted steel plate girders. The span over the main navigation channel is 300 ft., and the flanking spans are 203 ft. These are believed to be the longest continuous plate girder spans in Canada and have only been exceeded in size in a few instances anywhere. The plate girders are supported on reinforced concrete piers and footings founded on glacial till or on steel piles driven to glacial till.

The main features of the two lane Middle Arm crossing are as follows:

The east end is approximately 560 ft. long, extending from Lulu Island to the swing span at a grade of 3 per cent. This portion consists of 40 ft. simple span pretensioned concrete stringers supporting a reinforced concrete deck and resting on reinforced concrete caps and prestressed concrete friction piles driven about 30 ft. into a fairly thick layer of sand which overlays an extremely deep layer of silt and clay.

At the west end, 408 feet of approach spans extend from Sea Island to the swing span. This portion consists of eight 40 ft. simple spans of exactly similar construction to the east approaches plus one 88 ft. simple span of post-tensioned concrete construction. This span provides an 80 ft. horizontal clearance and a minimum 17 ft. vertical clearance which allows many small boats to pass under without opening the swing span.

In the main navigational channel, there is a steel plate girder swing span having a 60 ft. clear horizontal opening each side of the centre pier. The vertical clearance is 18 ft. above mean high water. An unusual feature of this span is that it is hydraulically operated, and because of the infrequency of the opening, there is no operator's cabin, all the controls being housed in a neat steel control panel which does not extend above handrail height.

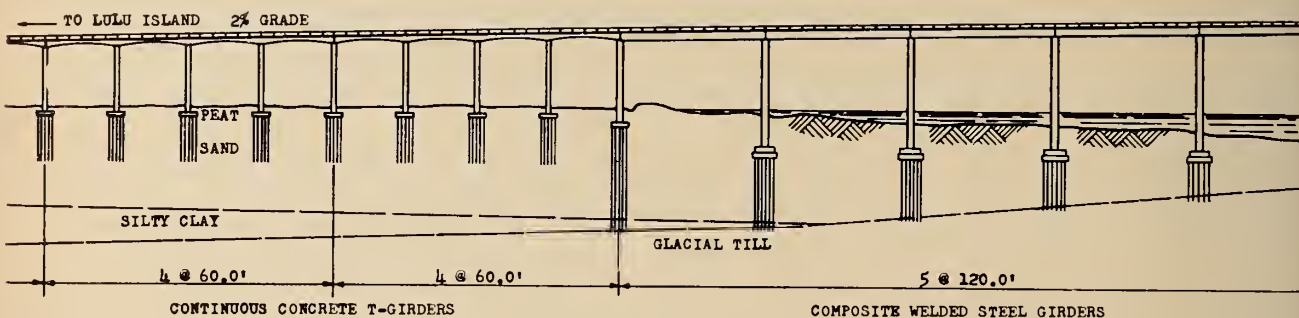


Fig. 2. Oak Street bridge profile, showing steel girder spans over the Fraser River and the beginning of the South (above) and North (p. 1821) concrete approaches.

The Oak Street Bridge Plate Girder

Before selecting a three-span continuous rivetted deck plate girder, a number of other types were considered. These included:

(1) A three-span continuous deck truss.

(2) A three-span continuous modified through truss.

(3) A three-span continuous rivetted deck plate girder consisting of four girders.

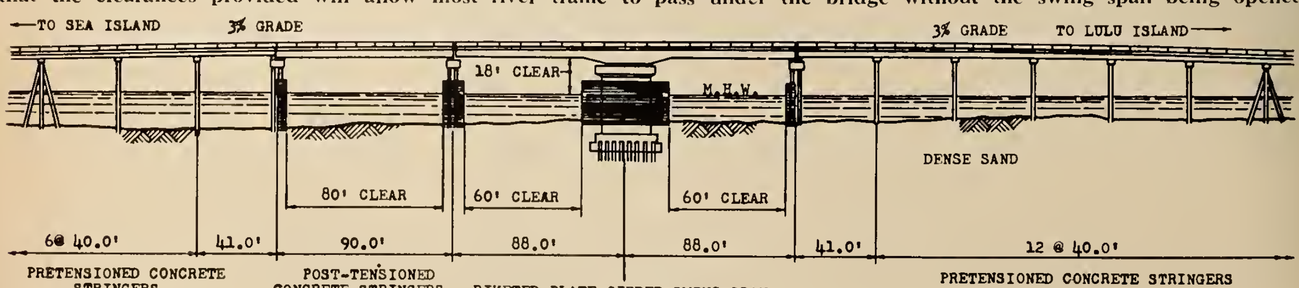
(4) A three-span reinforced concrete box girder with a centre 150 ft. masked suspended steel span.

All of these proved to be more expensive with the exception of the three-span continuous deck truss which appeared to be slightly more economical. However, a deck truss would have raised the elevation of the bridge above the fixed clearance over the channel, thus increasing the cost of the approach piers. When all factors had been included in the economic comparison, it was found that the two continuous deck plate girders would prove the most economical. In addition, there was no doubt in the minds of the engineers that a deck plate girder would be vastly superior in appearance.

A further study was made to determine the most economical deck system. The result of this study proved that a concrete slab spanning longitudinally between trussed floor beams spaced at 10 ft. centres was the most economic solution. In addition to reducing the steel in the deck system the trussed floor beams also eliminated some of the vertical sway bracing. To achieve added economy in the floor beams and to reduce the width of the main piers, the two plate girders were located 38 ft. on centres and the floor beams cantilevered on each side to support the curbs and sidewalks.

To achieve economy in the depth of the plate girders, a compromise had to be reached between the rigidity of the spans plus the resultant saving

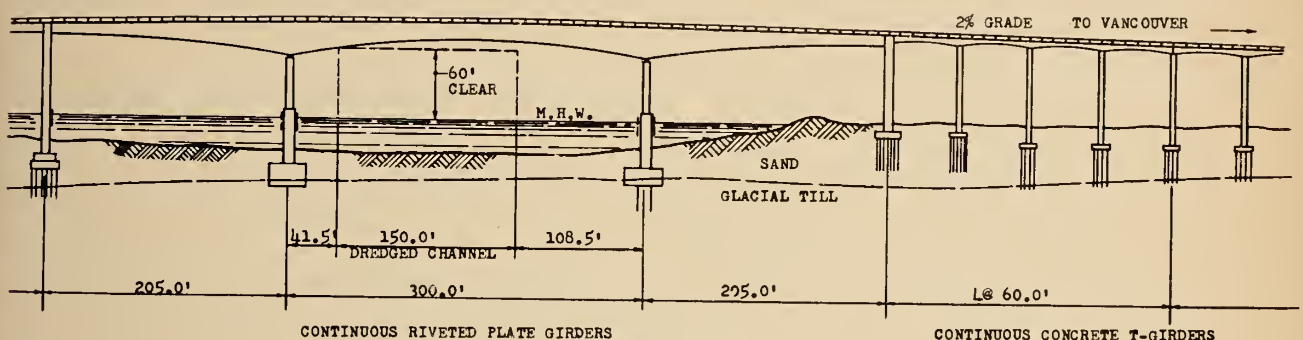
Fig. 3. Middle Arm bridge profile, showing steel girder swing span and prestressed concrete approaches. It is estimated that the clearances provided will allow most river traffic to pass under the bridge without the swing span being opened.



of steel in the flanges, which favoured a deep girder; and the saving of steel in the web plus fabrication and erection costs, which favoured a shallow girder. This compromise resulted in a 6 ft. depth at the exterior supports, a 21 ft. depth at the interior supports, and a 10 ft. minimum depth in the centre span. The upper flange of the girder was made parallel to the vertical curve of the roadway and the lower flange was established by elliptical curves for the flanking and centre spans. Silicon steel was found to be quite economical in this design and was therefore bending stresses but also permitted easier splicing. Side plates were also adopted because they added to bending resistance and decreased the unsupported depth of the web plate.

The "Specifications for Highway Bridges, 1951 (B.C.)" was used as the basis for design of web plate thicknesses where the formula involving the spacing of vertical stiffeners and the shear stress governed the design; all vertical stiffeners being spaced at 5 ft. on centres. Where the formula involving unsupported depth of web plate would have governed the design, horizontal stiffeners were provided every 20 ft.

The calculation of live load deflections of the plate girders revealed a maximum deflection of 4.10 in. in the centre span which was less than the allowable of 4.5 in. based on 1/800 of the span. Similarly, the live load deflection in the side spans was 2.92 in.; less than the allowable maximum of 3.02 in. To check on the possible problem of vibration, the consulting engineers visited and inspected the Passaic and Hackensack bridges, both somewhat longer plate girder spans than Oak Street. The observed vibrations on those bridges were not objec-



North approach.

specified for all the flange and web sections of the plate girder. Stiffeners, bracing and deck members were fabricated from medium steel.

Flange make-up offered some interesting alternatives. It was finally decided to follow a practice which has become quite common in European designs and which is being accepted among American designers, namely the use of two heavy angles in each flange and fairly thick and wide cover plates. This detail not only provided higher resistance to ers were provided and the webs were proportioned by the method outlined in the American Society of Civil Engineers Paper No. 2120 on the "Theory of Elastic Stability Applied to Structural Design", except that a safety factor of 1.8 was used instead of 1.4 as suggested in this paper.

Lateral K-bracing, designed to transmit the wind forces to the piers was provided in the planes of both the top and bottom flanges, and cross frames connecting the lateral bracing system...

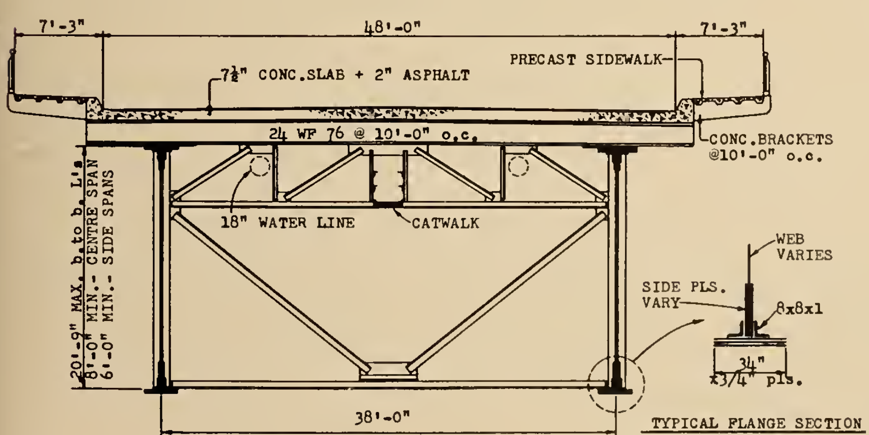


Fig. 4. Oak Street bridge plate girder details. Trussed floor beams contributed to a considerable saving of material in the deck system. Side plates were added to the plate girder flanges because they added to bending resistance and decreased the unsupported depth of the web plate

tionable and since the Oak Street girders compared favourably with these in relative stiffness, vibration was not considered to be a serious problem.

After considerable investigation of longitudinal forces acting on the plate girder spans, it was decided to provide fixed bearings at both interior piers and rocker bearings at the end piers. The two interior piers therefore share in resisting all the longitudinal forces due to temperature movement, wind, traction, and arching thrust under live load. The effect of the shrinkage of the roadway slab on the piers was reduced to a negligible factor by providing expansion joints in the slab every 100 ft. and painting the upper surface of the floor beam flanges with a bituminous compound to permit sliding of the concrete.

The Oak Street Bridge Approaches

Studies were made to determine the economic span and type of structure for the approaches on land and over water. On the basis of available cost data, 120 ft. post-tensioned concrete spans appeared to be the most economical over water and were proposed in the original design. However, when tenders were called for this portion of the bridge, alternate bids were invited and composite welded steel girders of similar span proved slightly cheaper and were chosen for the final design.

Studies for the approaches on land gave consideration to spans varying from 60 ft. to 120 ft. in poured concrete girder construction, composite concrete deck and steel stringers, and prestressed concrete. Continuous 60 ft. spans of reinforced concrete proved most economical based on costs prevailing at the time. In addition, the fact that this type of construction would require little or no maintenance led to its choice.

The decision to use four continuous spans of 60 ft. was based on the obvious economy due to continuity. Fixed bearings at all interior supports of these spans presented no problem in the design of either the deck system on the piers, and made for economy. Since soil studies had revealed the possibility of differential settlements up to ⅜ in., particularly on the south side, the four 60 ft. continuous girders were checked for a possible differential settlement of ½ in. and the stresses for this condition did not prove critical. The effect of deck shrinkage on the intermediate piers was also checked and it was found that the resultant stresses in both the very high and low pier shafts were not excessive.

Alternatives were considered for the support of the 48 ft. roadway and the two 7 ft. sidewalks. Five, six, and seven girder decks were investigated in turn, and it was found that the five girder deck was the most economical. The use of fewer girders also led to some saving in the cost of bearings. These girders varied in depth from 3 ft. 6 in. at the centre of each span to 6 ft. 0 in. at the supports, with diaphragms transversely every 20 ft. to stiffen the deck system. By pouring the curbs monolithically with the exterior girders and placing the negative reinforcing up into the curb, added resistance and economy were achieved in these girders. A further economy was realized by using precast lightweight concrete sidewalk slabs spanning 10 ft. between concrete brackets which also supported the steel handrail posts.

An interesting feature of construction was the manner in which the contractor overcame the problem of supporting the formwork for the deck system, particularly on the southern approaches. Soil studies on Lulu Island has revealed that if the deck concrete were supported on falsework to the ground, the dead load of the deck would be applicable in calculating settlements in the sand. If, on the other hand, the forms and wet concrete loads were carried to the piers, only the live load would contribute to settlement. The differential settlement due to the former condition would have amounted to about ⅞ in., which would have been critical in the design of the deck girders. As a result, the consulting engineers specified that the deck forms would have to be carried to, and supported on the piers. The problem was overcome by using glulam timber trusses, the upper chords of which were curved to suit the parabolic soffit of the girders. These trusses were designed to span between the piers and supported the formwork of the bridge deck, being re-used throughout the length of the approaches.

The Middle Arm Bridge

A swing span was adopted for the moveable bridge portion since both a vertical lift and bascule bridge were considered by the airport authorities to be a hazard to low-flying aircraft landing or taking off from the airport nearby.

Studies revealed that the approach spans of prestressed concrete beams could vary from 20 ft. to 40 ft. without any significant difference in cost. It was therefore decided to use 40 ft. spans which, in addition to their more pleasing appearance, would require less construction time for the pile bents.

Consideration was given to 16 in., 18 in. and 20 in. prestressed concrete piles for the approach bents. It was found that the 16 in. pile resulted in a cheaper bent. The smaller sized pile also had the additional advantage of being easier to drive.

A generous 28 ft. roadway was provided for this crossing to permit the flow of single lane traffic each way even in the eventuality that a car broke down on the bridge. Two sidewalks of 5 ft. were also provided.

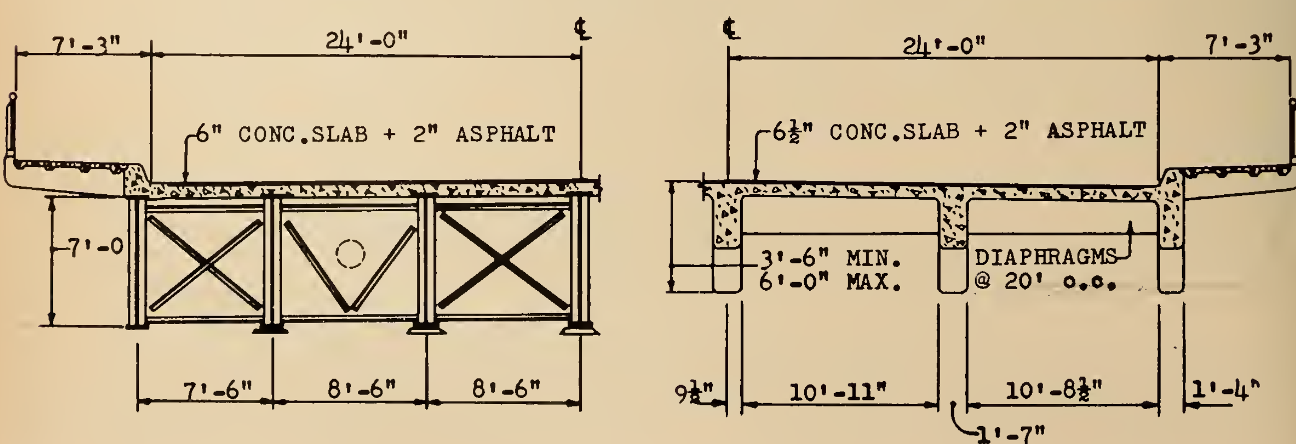
In the swing span, the two plate girders are half-through and 31 ft. on centres. The concrete deck is supported on stringers spaced at 5 ft. 9 in. o.c. spanning 21 ft. 4½ in. between floor beams.

The approach roadway is supported on seven prestressed beams. The 40 ft. span beams are I-shaped, 36 in. deep and pretensioned by seventy-four 0.195 in. diameter H.T.S. wires whose ultimate strength is 240,000 p.s.i. The concrete in these beams has an ultimate compressive strength of 5000 p.s.i. The 88 ft. span beams are 45 in. deep and post-tensioned by eight 12-wire, 0.276 in. diameter h.t.s. Freyssinet cables. The ultimate tensile strength of the wires is 220,000 p.s.i. and the ultimate compressive strength of the concrete is 6000 p.s.i.

Bridge Deck Lighting

One of the unusual features on

Fig. 5. Oak Street bridge approach deck details: composite welded steel girders and typical continuous concrete T-girders.



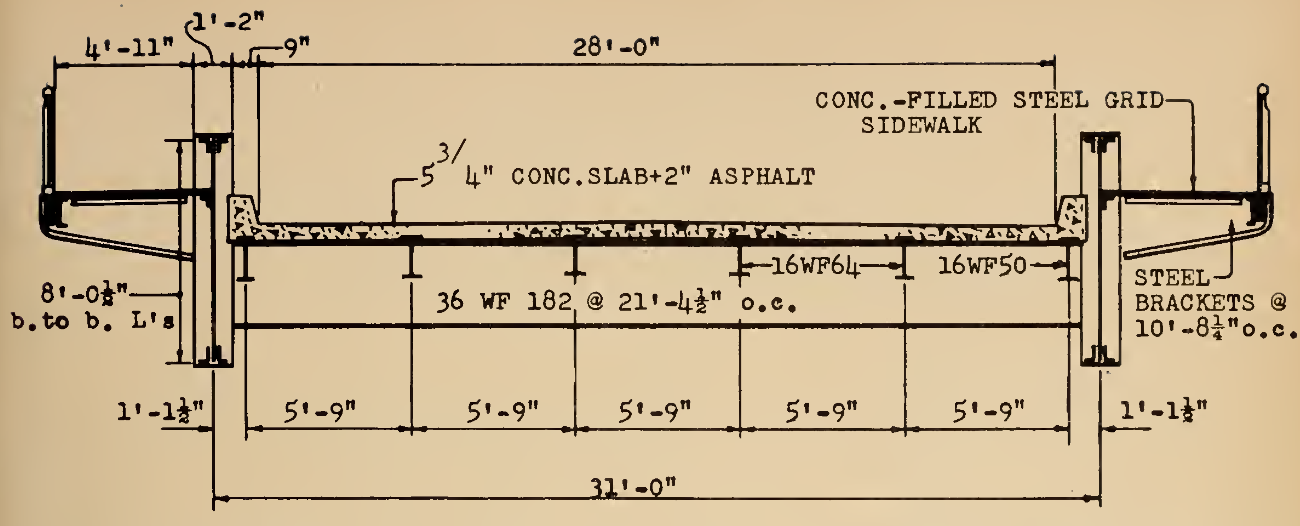


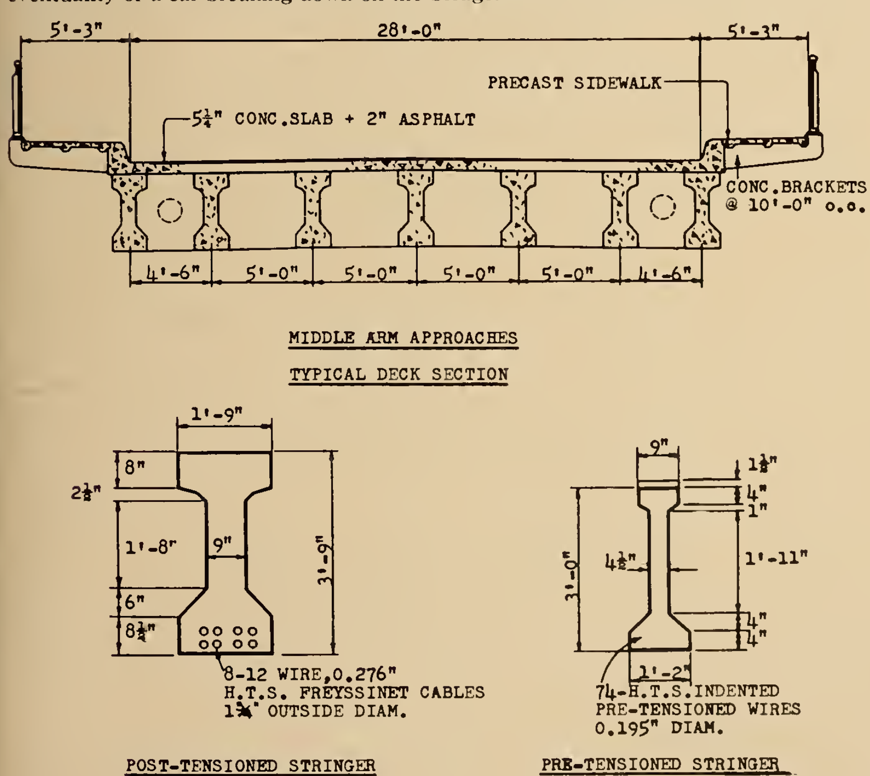
Fig. 6. Middle Arm bridge girder swing span. Because openings are infrequent, the swing span has no operator's cabin. All controls are housed in a neat steel panel (not shown here) adjacent to the girder and no higher than the handrail.

both bridges is the use of fluorescent luminaires to provide lighting for the bridge decks. Mounted on metal poles, these luminaires extend about 29 ft. above the roadway and are generally spaced at 80 ft. centres staggered on each side of the deck. The luminaires are tilted some 20 degrees from the horizontal permitting improved light on the roadway.

Tests have indicated that this type of lighting provides the highest luminous efficiency combined with a minimum of objectionable brightness; true colour discrimination of objects, and the longest average burning length. With four fluorescent lamps per luminaire, there is the added advantage of partial light output should one of the lamps fail.

This type of lighting was first used on the Richmond-San Rafael bridge in the San Francisco Bay area (completed September 1, 1956). It is believed that the Oak Street and Middle Arm bridges mark the first application of this advanced bridge lighting feature in Canada.

Fig. 7. Middle Arm bridge approach deck details. A 28 ft. roadway was provided for this crossing to permit the flow of single-lane traffic each way, even in the eventuality of a car breaking down on the bridge.



Basis of Design

The design of the entire project was generally based on the "Specifications for Highway Bridges—1951", issued by the British Columbia Department of Public Works, and the 1953 "Standard Specifications for Highway Bridges" of the AASHO. The assumed live loading was H20-S16-44 truck or lane load. The design also called for poured concrete to have an ultimate compressive strength of 3000 p.s.i. at 28 days and the reinforcing steel to be Hi-bond intermediate grade with a working stress of 20,000 p.s.i.

Summary of Costs

A general review of the cost of both bridges reveals the following lump sum figures:

Oak Street Bridge

General contract — approaches and substructure	$3,477,000
Plate girder — medium steel (575 tons)	239,000
Plate girder — silicon steel (760 tons)	347,000
Materials supplied by the B.C. Toll Authority	438,000
Re-location of high tension power lines	75,000
Connections and alterations to Vancouver streets	135,000
Total	$4,711,000

Middle Arm Bridge

General contract — approaches and substructure	$ 532,000

Swing span steel and machinery	185,000
Materials supplied by the B.C. Toll Authority	38,000
Total	$ 755,000

The above figures do not include the cost of property acquisition, removal of buildings, new roads on Lulu Island or engineering. A more detailed study of these costs yielded the following unit costs per square foot of bridge, based on the width of the bridges from in to in of handrailing:

Oak Street Bridge

(1) Plate Girder Spans:

Substructure	$ 8.29/s.f.
Superstructure	18.10/s.f.
Total	$26.39/s.f.

(2) Four 60 ft. contin. conc. girders: (four lanes)

superstructure	$ 5.35/s.f.
substructure (average)	2.55/s.f.
Total	$ 7.90/s.f.

(3) 120 ft. span comp. conc. deck and steel beams:

Superstructure (over water)	$ 9.29/s.f.
substructure	8.37/s.f.
Total	$17.66/s.f.

(4) Average cost of entire bridge .... $11.15/s.f.

Middle Arm Bridge

(1) Swing span (incl. machinery)

superstructure	$29.00/s.f.
substructure	16.80/s.f.
Total	$45.80/s.f.

(2) 40 ft. prestressed spans:

superstructure (over water)	$ 5.85/s.f.
substructure	3.40/s.f.
Total	$ 9.25/s.f.

(3) Average cost of entire bridge .... $16.90/s.f.

These costs, based on contracts concluded in 1954, were lower than those originally estimated by the consulting engineers, indicating that the design in general was a most economical one. It would therefore seem that the time spent on the numerous economic investigations was most worthwhile. The design and supervision of the entire project was carried out by Phillips, Barratt and Partners, consulting engineers, in Vancouver. Dominion Bridge Co. Ltd. was responsible for the supply and erection of all the structural steel.

General contractor for the Oak Street Bridge was Gilpin Construction Co. Ltd. Vancouver Pile Driving and Contracting Co. Ltd. was the general contractor for the Middle Arm Bridge. Commissioned to do the electrical design for both bridges was M. A. Thomas, P.Eng., and retained for the mechanical design on the Middle Arm Bridge was G. Bancroft, P.Eng.

Electrical and Mechanical Design Features of the Queen Elizabeth Hotel

(continued from page 1814)

with their own dishwashing facilities.

Refrigeration

Refrigeration for food preservation is provided by numerous "reach-in" refrigerators as well as large "walk-in" refrigerated rooms carried at suitable temperatures from 40° F. down to -15° F.

The cooling is accomplished by a number of Freon compressor condenser units strategically located to keep runs of refrigerant piping to a minimum. These units are served by condensing water which is circulated from two cooling towers located on the roof over the third floor.

Ice-making is carried out as far as possible with individual cube and flake ice machines, located as near as possible to the areas to be served. In addition, three combination cube and flake ice machines, each with a capacity of one ton in twenty-four hours, are provided to take care of peak demands.

DISCUSSION

of Technical Papers and Other Articles

THE FOUNDATION FAILURE OF THE TRANSCONA GRAIN ELEVATOR

A. Baracos, M.E.I.C. *The Engineering Journal,* 1957, July, 973.

Lionel L. Jacobs,[1] M.E.I.C.

I was much intrigued with Baracos' article on the Transcona grain elevator failure. There probably are not too many men still alive who saw this at first hand. When this happened the C.P.R. were building the great sorting yard at Transcona, and also a creosoting plant.

In 1910 I came out from London, England, to supervise the building of a tar distilling plant for the Dominion Tar and Chemical Company at Sault Ste. Marie, to take the tar from the new Algoma Steel Company coke ovens, and in 1912 to 1914 I had wished on to me over-all supervision of the C.P.R. creosoting plant at Transcona. We were only a short distance from the elevator, and I well remember the excitement when it was found to be tipping, and coming back the next morning to see it tipped at about 25° and the cupola slid off.

I was around all through the wonderful job, done by The Foundation Company, of putting down Chicago wells, and righting the bins, and in constant contact with the field force. It was a delightful experience for a man who was only just beginning to cut his teeth on big jobs. It pleases me so much now to read the excellent article by Baracos explaining the theory.

A. P. Balodis,[2] M.E.I.C.

As far as some problems might be considered, besides the check on the soil bearing possibilities for this particular case of failure, it would also be of interest to know of any other investigations carried out.

(1) I would like to know the reason for the acceptance of $\phi = 0$ in bearing capacity determination for this particular case of varved clays present on the site. If the value of "unconfined compressive strength" is about $0.9/\text{ft}^2$, and also keeping in mind the calculated value of I_c, the clay is believed to be "plastic", but nevertheless perhaps a "stiff" one. Presence of the Montmorillonite clay must be taken into account also, and considering these facts it might be expected that the "low" unconfined compressive strength does not expose clearly the actual value of the angle of internal friction, especially considering the particular structure of the varved clays. In which direction were the samples tested considering foliation of the varved clays? Also, is it correct to consider behaviour of the varved clays as being more similar to the same of silty soils than of clayey ones? It is doubtful if in this particular case the $\phi = 0$ method is acceptable, and anyhow, it is only of secondary importance.

(2) Of greater significance than the studies on bearing capacity of the varved clays on the site is the probable causes of the "foundation failure", and it would be of interest to see some information on the results obtained by investigation done (if any) considering the problems which are briefly outlined below:

(a) As the varved clays are critically sensitive considering the possibilities of the loss of "strength", i.e. bearing capacity, due to excessive wetting or freezing, the results of the investigations on the climatological factors involved in stability would be of interest. For instance, could any heavy rain periods during the excavation or elevator construction time be determined at the present time? Did any frost occur? How long did the excavations remain open?

(b) As the Montmorillonite clays exhibit high plasticity, low "strength" and are sensitive to the harm produced by any change in physico-chemical conditions, (this change might be expected due to the loading of the strata) it would be interesting to hear the results of investigations (if any) considering the possibilities to determine the thermal change which occurred beneath the elevator during and after construction? Was any chemical analysis of the clay performed? Did the soil contain any gas filled pores?

(c) Every new structure changes considerably the micro-climate beneath it. For instance, the capillarity zone might fluctuate due to the rise of the ground water level caused by the warmer climate which has been established underneath the foundations. Were any ground water observations performed and results obtained? Are the silt pockets large enough to change considerably the hydraulic gradient of water flow? Were drainage possibilities within the strata changed by the erection of the elevator? Were previous conclusions on the cause of failure (fluidization of deeper strata?) considered and rejected?

(d) Since the varved clays are of "unstable" bearing strata if foliation is disturbed or demolished, it would be of interest to know the information obtainable at the present time considering this problem. Was any excavation in the vicinity performed to expose the lamination of the varied clays considering possible inclination of the clay layers? Or, for instance, were the possibilities considered of the lifting up of separate layers by silty layers, (or pockets), during the time while the excavation was open and settling the layers again after the construction was completed (which

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[1] Lionel L. Jacobs & Son, Wayne, Pa.
[2] Design Engineer, Polymer Corporation Ltd., Sarnia, Ont.

might cause the differential settlement). The bearing capacity might be very high but the structure would collapse.

(e) As the cause of "Transcona Elevator Failure" is known worldwide and has been discussed many times (even mentioned in German and Russian text books) it will be of interest to know the results of investigations performed (if any) referring for instance, to the structural problems drawn by L. E. Vandergriff and pointed out by J. Feld, Ph.D., considering the method which was employed in filling the elevator and also the probability of uneven loading at the contact plan of the foundations. (Boston Society of Civil Engineers, p.108, volume 43, 1955).

As far as $3t/ft^2$, as the allowable bearing value for the case of the varved clays, was successfully accepted without the troubles in other cases, the cause of failure due to shear failure or "low" bearing capacity is questionable. Also, every one post-determined theoretical bearing value might be more or less "adjusted" to the required limit by *different formulae* or factor of safety using. In the case of the Fargo, N.D. elevator failure there are three different opinions given, also in this particular case different opinions might exist, but the investigations should help the practising engineer to become acquainted with all the problems which might be considered. In the book "Engineering Structural Failures" by R. Hammond, the pictures of the Transcona elevator are presented, but the text is omitted due, I suppose, to the limited and perhaps contradictory information available at the present time on the true causes of failure.

The Author

Mr. Balodis has apparently chosen to ignore the fact that both the cause and nature of the foundation failure of the Transcona elevator were primarily mechanical. The overturning of a structure, too heavily loaded to be supported on a cohesive material shown by laboratory tests to have an appreciable shearing strength, involves no principle more complicated than that of static equilibrium at impending failure. The formulae for the ultimate bearing capacity involve only such equations for the forces tending to cause, and resisting motion.

The properties attributed in the discussion to the clays that supported the elevator, including the vaguely described "physico - chemical", changes in chemical nature, high sensitivity to loss of strength, liquefaction, moisture migration, etc. were not indicated to be significant factors in the field and laboratory testing, in reliable accounts of the failure itself nor in any experience with foundation work in the Greater Winnipeg area where the same soils are found and many structures have been built.

Regarding the $\phi=0$ analysis, it is not of secondary importance as suggested. It is only when $\phi=0$ that the shearing strength of a soil can be taken as half of the unconfined compression strength. The fact stated in the paper that 12 representative samples were tested in triaxial compression to establish this relationship was apparently overlooked in the discussion. Also overlooked were the facts that the clays were saturated (no air voids), that the varves were only of fractional inch thickness and nearly horizontal, and that the loading of the elevator was uniform. These observations were based on careful study.

That the varved clays at the elevator site had predominantly clay properties was amply demonstrated by the Atterberg limit, the grain size and their behaviour in the triaxial compression tests. Although not stated in the paper, the clay properties were also demonstrated by the low permeabilities as determined from the consolidation tests. The points raised in the discussion are readily clarified when *all* the pertinent data presented are considered.

For further information it is stated that the major principal stress in the strength tests was applied in the vertical direction of the samples. Regarding soil moisture conditions at the time of the failure there is no evidence to indicate that varved clays were other than saturated at the time of the failure. That $\phi=0$, can be readily demonstrated to be applicable for saturated fine grain soils when loading is too rapid to permit consolidation. It is a well known fact that consolidation under any pressure increase of a deep layer of fine grain soil of low permeability takes many years. The loading of the elevator with grain took only about a month.

Presumably the differential settlement mentioned in the discussion refers to the tilting action of the elevator which is readily explained. It will be seen from Fig. 2 in the paper that the structure had relatively a shallow foundation compared to its height and that the centre of gravity of the entire structure was well above the ground surface. Both these conditions are recognized in static mechanics to constitute relatively unstable equilibrium for a structure supported on a raft type foundation. Any slight eccentricity of loading or support can favour tilting to one side in preference to the other side at impending failure.

I would like to assure Mr. Balodis, that no "adjustments" of any formula were made. The same formula used by Skempton (Building Research Congress I: 180-189, 1951) and by others was employed and the nature of its derivation has been already explained. The use of the formula has been justified by studies of other notable failures and by model studies.

The statement that 3 tons per sq. ft. had been used successfully in other cases is incorrect. Many buildings older than the Transcona elevator are found in the Greater Winnipeg area supported on the varved clays. Soil bearing values for these and newer buildings generally range from 2000 to 3000 lb. per sq. ft., not 6000 lb. per sq. ft.!

Regarding references to the Transcona elevator foundation failure in text books, I would like to state that only Dr. Peck's and the writer's investigations included soil testing and the results of both investigations have only recently been published. Without such testing any analysis of the failure would only be a matter of conjecture.

Mr. Balodis has not stated what the three different opinions were on the N.D. elevator and to which elevator he was referring, nor has he stated if these opinions had been substantiated by actual tests. It is not possible therefore to appraise these "opinions".

It was a most gratifying experience to receive Mr. Lionel L. Jacobs' comments and eye-witness account of the Transcona grain elevator foundation failure. Had the writer known of Mr. Jacobs at the time of the investigation, he would have been delighted to have consulted him on many of the details of the actual failure. Such accounts are invaluable in the reconstruction of past engineering events. It may be noted that even at that time, some forty-five years ago, the significance of this failure had been recognized by the engineering profession.

ABSTRACTS

BASED ON CURRENT LITERATURE AND EVENTS

ORIGIN OF THE FOOT-MEASURE

C. St. C. Davison, *Engineering*, v. 184, n. 4778, October 4, 1957

When man had reached a certain stage in evolution he found it necessary to convey impressions of size. Thus he described a piece of wood as being as long as his arm. Or an amber ornament as thick as his finger. The length of the forearm from the point of the elbow to the tip of the middle finger, later known as a cubit, then became a standard of measure; the span and the widths of the palm and the finger were regarded as proportions of the cubit. This system had the drawback that men varied in size, and consequently leaders of communities started to insist on the measures being marked off on wood, or stone for general use. As a result, standards of length thus made were built into the most conspicuous walls of a structure. This practice tended to increase accuracy and also to prevent arguments among tradesmen.

The art of measuring was probably conveyed from Persia or Northern India to Babylonia. The Tower of Babel (or Babylon) was built using a simple cubit measure. An Egyptian royal cubit of about 2600 B.C. shows an average length of 20.8 in. Expanding civilizations needed greater precision in measurement. Egyptian royal cubit - rods of about 1540 B.C. were made of hardwood from the Sudan and inscribed with 28 digits, a digit being one finger's breadth. The first 15 digits from the right were progressively subdivided into from 2 to 16 parts. Also, a knotted cord for land measure was used in Egypt around 1400 B.C. and is comparable to the surveyor's chain used today.

In the sixth century B.C. the Assyrians had a wooden cubit which was divided into six palms, each alternate palm being subdivided into four digits. The overall length of this rod was 21.05 in., although it has been found from records and calculations from buildings to lie between 21.37 and 21.6 in. Its front had a central division to indicate two Eastern feet. Both as a cubit and a foot-measure it was a very widespread unit and has been traced to the following regions: Assyria (21.37 inches), Persia (21.375 in.), Egypt (21.4 in.), Italy (21.375 in.), France (21.32 in.), England (21.48 in.), and Scotland (21.34 in.).

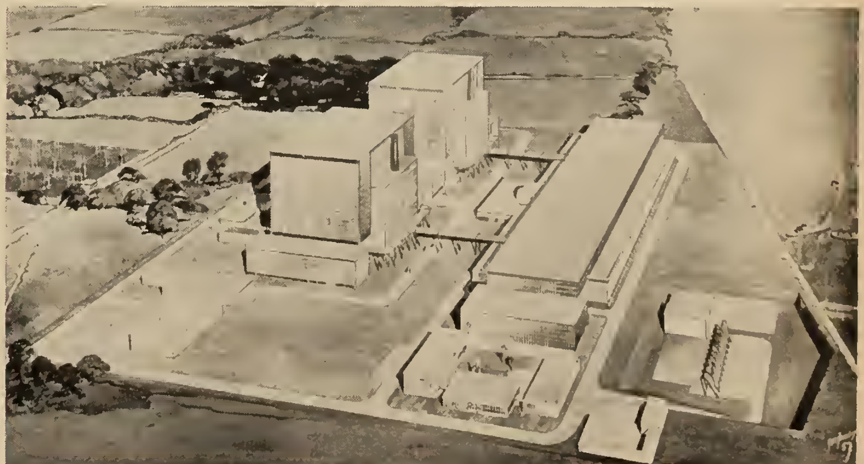
The success of the Roman Empire and general increase of trade led to more settled conditions, and standards for measurement became even more important. The cubit was accurately subdivided into seven palms by six vertical lines; its value averaging 26.8 in. A Graeco-Roman marble notice with a foot-measure inscribed on it shows the foot to be 12.17 in. long. It was known as the Greek Olympic foot.

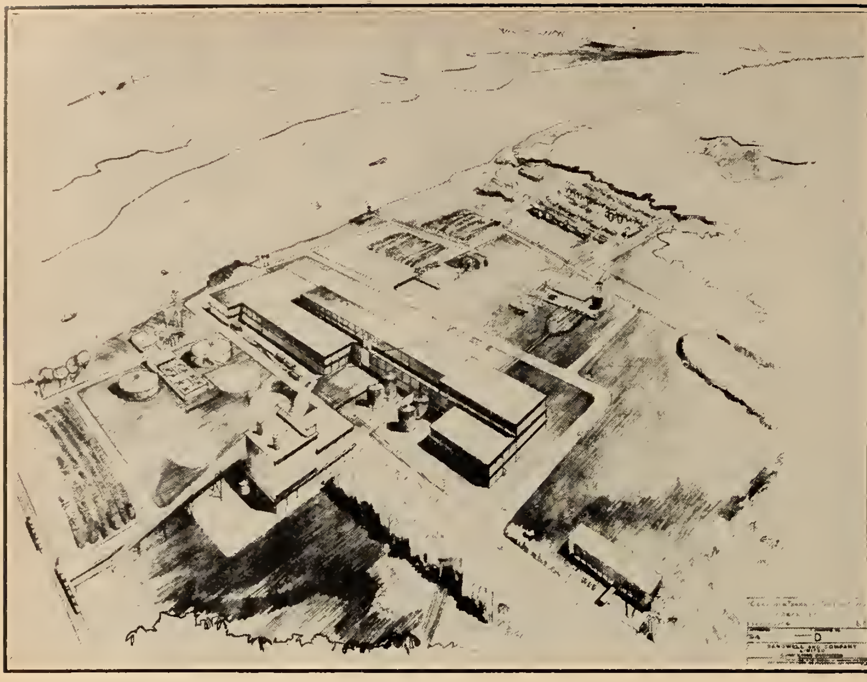
Many countries reverted to more primitive measures when the Romans left them. For instance, the Saxons in England had a measure consisting of 3 barleycorns to 1 thumb (1.1 in.), 3 thumbs to 1 palm (3.3 in.), 4 palms to 1 Saxon foot (13.2 in.). Grains were not very satisfactory as a basis for a measuring system, due to variation in size. The Chinese had a similar system many years earlier.

After the fall of the Roman Empire the Arabs continued to pursue the arts and sciences, and some of the better standards were brought back by them to Europe. Charlemagne (A.D. 771 to 814) was thought to have received a cubit which was derived from that of Darius the Great, King of Persia, Assyria and Egypt (521 to 435 B.C.), which in its turn was derived from the Assyrian cubit. Half of this cubit became what was called the "pied du roi" and remained the official French foot until replaced by the metric sys-

WORLD'S LARGEST ATOMIC POWER STATION

An artist's impression of the atomic power station to be built by the English Electric-Babcock & Wilcox-Taylor Woodrow group at Hinkley Point, Somerset, for the Central Electricity Authority, in Great Britain. When completed, this will be the largest station of its kind, with a net output of 500,000 kw. Two gas-cooled graphite-moderated reactors, fuelled by natural uranium, will be used in the plant.



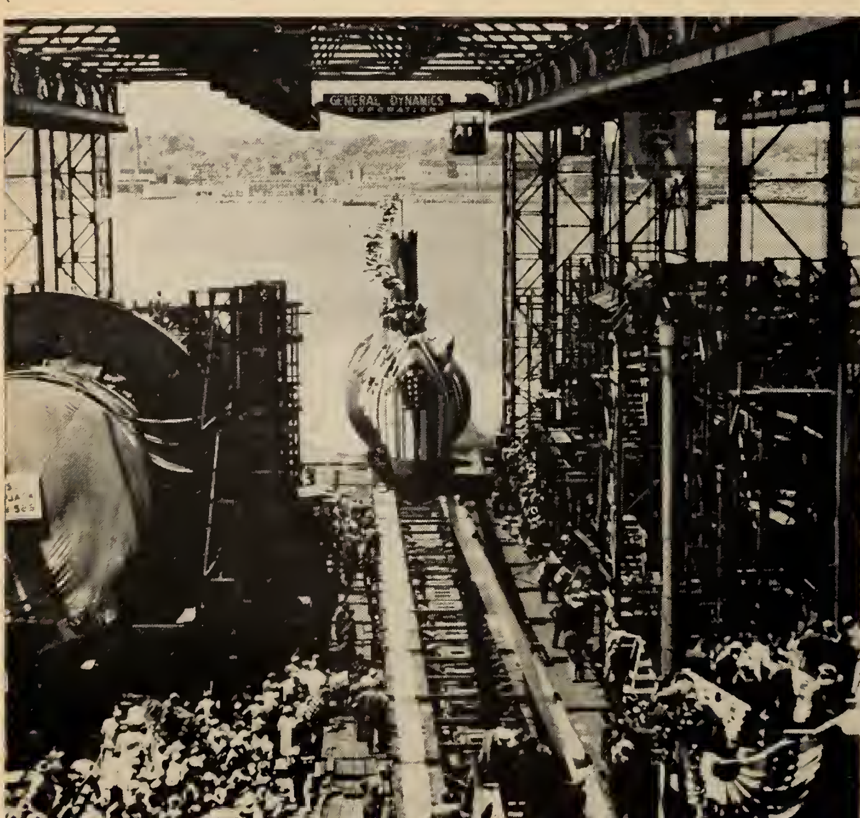


NEWSPRINT PLANT FOR PAKISTAN

Perspective drawing of new $20 million newsprint plant now being built for the Pakistan Industrial Development Corporation. Main mill block, centre; administrative offices, right foreground; chemical preparation and wood treatment plant, centre background. The building with twin smokestacks in centre foreground will house the steam and power plant. Production is scheduled to start in 1959. Consulting engineers for the project are Sandwell and Company, of Vancouver, B.C.

NUCLEAR SUBMARINES IN PRODUCTION

Shown at its launching earlier this year is the first production model nuclear submarine *Skate*. Under construction are the *Skipjack*, left, and the *Triton*, right. (Photo: Ex-Cell-O Corporation, Greenville, Ohio.)



tem during the Revolution (1791). The metre was taken as the one ten-millionth part of a meridional quadrant of the earth, and geodetic measurements to obtain this value were made on the meridian passing through Dunkirk and Barcelona.

Although reverting to the length of the barleycorn as a standard, the Saxons still clung to the Northern Foot for measuring land. This foot, at 13.2 in. can be traced back through various countries to early times in Babylonia. Many different units existed in early English measures and it was difficult to enforce a single standard. Iron yard - bars were made under King John but they were not subdivided into inches because the inch was still governed by the length of a barleycorn. This state of affairs continued until King Edward I made an iron "ulna" (early name for the yard) in 1305 which measured nearly 36 in. and was subdivided into 3 feet, each of nearly 12 in. Henry VII obtained a new standard yard similar to King Edward's, and Queen Elizabeth I authorized another which remained in use as a standard until 1824. It was the basis for measurements of length for Thomas Newcomen, James Watt, and other famous engineers.

Watt's micrometer (1772) which was graduated according to the length of this yard was constructed to read to 1/1800 in. Later Joseph Whitworth made (1834) a measuring device which could be read to an accuracy of one millionth of an inch. The Royal Society of London commissioned (1742) George Graham to produce a better yard measure than Queen Elizabeth's. Attempts in France about 1778 to increase accuracy of production with interchangeable parts for firearms and the successes of Eli Whitney in America led to rapid development of technology. A Royal Commission (1758-1760) prescribed a new yard measure with a dot cut into a gold stud at each end. It was made the legal standard in 1824 but was destroyed in a fire ten years later.

The current imperial yard was constructed in 1845. Studies were made to find the best metal alloy for the purpose, the correct shape and the effects of temperature variation upon its accuracy. Copies of the standard are now kept at the Royal Mint, the Royal Society, the Royal Observatory, the Houses of Parliament, and also the Standards Department of the Board of Trade.

ZINC SOLDERING OF ALUMINUM

I. B. Robinson, *The Welding Journal*, v. 36, no. 10, October, 1957

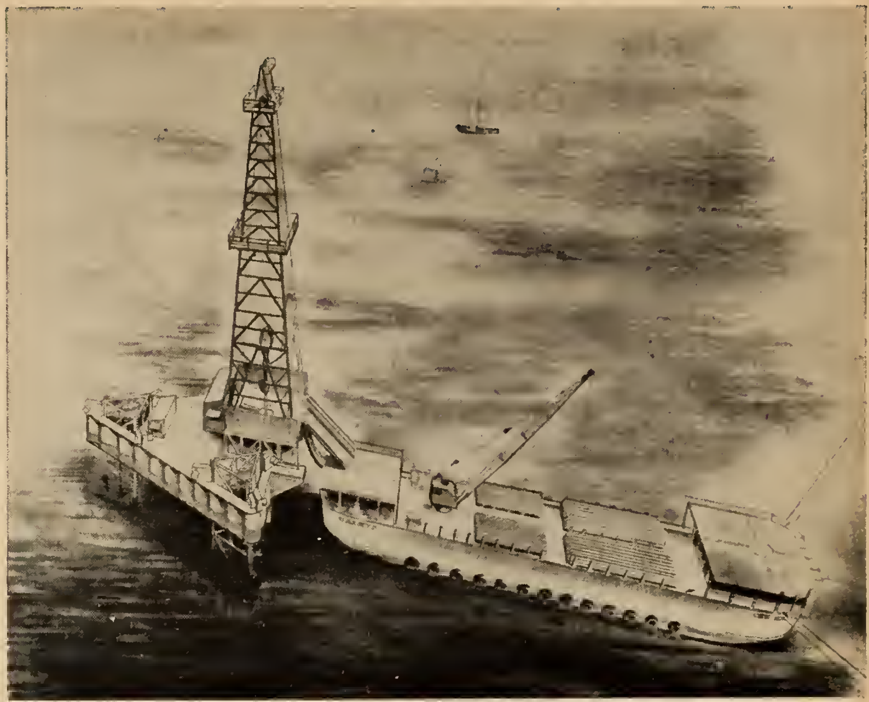
Zinc soldering with the proper fluxes, solders, and procedures is a simple method for joining aluminum to itself and dissimilar metals at intermediate temperatures to provide strong joints which are easy to make and are corrosion resistant.

Zinc solders may consist of zinc or zinc alloys containing from 90% to 100% zinc with varying amounts of higher temperature melting metals such as aluminum, silver, copper or nickel. The melting points of the solders range from 720 deg. to 800 deg. F. and because of the high zinc content are much cheaper than the common soft solders. These solders can be applied to the joint from solder-coated aluminum sheet, from added wire or shims, or from a molten solder bath. The fluxes are inorganic salts, chlorides and fluorides, mixed with water or organic solvents (normal-propyl and normal-butyl alcohol) for application. Flux residues left after joining must be removed since they seriously lower resistance to corrosion. The residues from an alcohol slurry of flux can usually be removed by washing in hot water. If the flux has a low content of zinc chloride a better procedure is to wash in hot water, dip in dilute sodium hydroxide solution, water rinse, dip in dilute phosphoric acid solution, water rinse and air dry.

Any of the commercial forms of nearly all the aluminum alloys can be joined by zinc soldering, although the high strength, heat - treatable alloys are not recommended. The solderability of aluminum alloys is slightly reduced by the presence of silicon. In general, castings are more difficult to solder than are wrought products. The temper of an aluminum alloy has no effect in itself on solderability, but heat-treating films, particularly on alloys containing magnesium, reduce effectiveness of the fluxes. These heat-treating films, can be removed by treatment with sodium hydroxide or hydrofluoric acid solutions.

Furnace, torch, molten metal dip, and resistance soldering can all be used. Tube-fin constructions, socketed tube joints, transition joints, and cellular products are some of the many assemblies that have been joined.

Zinc-soldered joints between aluminum parts are stronger than where soft solders are used, and they are generally stronger than the commonly soldered aluminum alloys. The



MOBILE PLATFORM FOR OIL DRILLING

A mobile tender-type platform to be built for Arabian American Oil Company at a cost of $750,000. Crew accommodation and most of the main power supplies will be housed on the tender. Mud lines, power cables, and other services run from the tender to the platform below the skid ramp. (Photo: R. G. LeTourneau, Inc., Longview, Texas.)

NEW FIGHTER-BOMBER

The supersonic F-105 Thunderchief is the latest fighter-bomber of the U.S. Air Force. It is a 63 ft. long single-seater, powered by a Pratt and Whitney J-75 turbojet engine of the 15,000-lb. thrust class (not counting additional afterburner power). The last 3 ft. of fuselage can be opened out in sections at right angles to act as an air brake.

tensile strengths of zinc solders will be in the range of 15,000 to 40,000 p.s.i. depending on the composition. Socketed joints designed to fail through the solder gave a shear strength of 18,000 p.s.i. for a zinc-aluminum solder, a strength greater than the shear or tensile strength of many of the common aluminum alloys.

The joints have good resistance to corrosion when high-purity solders and proper flux removal procedures are used. Zinc - soldered aluminum joints will last many years in ordinary atmospheres.

AN ACCELERATED TEST FOR PORTLAND CEMENT CONCRETES

J. W. H. King, *Civil Engineering*, v. 52, No. 614, Aug., 1957.

Exhaustive tests have been carried out at Queen Mary College, University of London, on a wide variety of concrete mixes. Sand and aggregate were varied in grading and proportions, the water to cement ratio was varied to give concretes ranging from too wet to too dry, and numerous different Portland cements were used including normal and rapid hardening with some special kinds of cement such as sulphate-resisting, oil-well, and hydrophobic.

As a result of these tests it has been found possible to predict the 7 and 28 day strength of a concrete cured in the normal way at 20° C. under fully humid conditions, by testing specially treated sample specimens a few hours after mixing. The results on unknown materials are predictable within ± 250 p.s.i. or so, with a 90 per cent certainty using standard curves plotted from the test data. Where materials from constant sources are used on a particular site, the curves may be corrected to fit the local findings as the work proceeds, so that the error can be reduced to about half of the above value.

The specimens which have been used in England have been mainly 4 in. cubes, but many checks with 6 in. cubes indicate the test to be equally reliable. No tests have been carried out on 12 in. x 6 in. cylinders. Three different procedures have been used, and are outlined. The first which is standard takes 7 hours from mix to test but as this is not always convenient on engineering works, alternatives taking 23½ and 26 hours have been evolved.

The same curves apply for all methods but there is a slightly increased scatter with the longer times. The scatter is such that the 7-day value cannot be used with success for predicting the 28-day strength, although the accelerated strength will predict both reliably. Any departure from the standard procedures will probably cause so much scatter with different cements, that the tests cannot be considered reliable unless separate curves are produced using the new procedure for each cement.

It is requested that any who care to employ this method of accelerated testing should report their findings to the author, Professor of Civil Engineering, Queen Mary College, Mile End Road, London, E.1, where reports from world wide tests are being examined and correlated.

NEW INTERNATIONAL STANDARD OF LENGTH

A long step forward into the future may result from a resolution recently passed by the Advisory Committee for the Definition of the Metre. This body of international experts has decided that the world standard of length should no longer be "M"—the bar of platinum-iridium kept in Sevres, France—but a wavelength of light. Thev have chosen one of the wavelengths of orange light emitted bv isotopic krypton, of atomic weight 86.

The decision was based on recent research in the U.S.A., Russia, Japan, West Germany, France, England, and Canada. The Canadian work was done in the laboratory of Dr. K. M. Baird, head of the Interferometry Section, Division of Applied Physics, National Research Council. In the past five years, Dr. Baird has built up one of the most distinguished interferometry laboratories in the world, equipped with many pieces of unique apparatus, including several of his own design.

The use of light as a yardstick has been attractive for some time—ever since it was first suggested by J. Babinet in 1827. One hundred years later, in 1927, a relationship was accepted between the physical metre and a red line of cadmium, mainly for the use of spectroscopists. But no known light source was entirely suitable as a base for the metre until recent years, when isotopes became available.

For the past few years, top contenders were mercury 198 (transmuted from gold—an interesting product of nuclear research), krypton 84, krypton 86, and cadmium 114. All of these had excellent characteristics, and it was a long time before krypton 86 won by unanimous decision.

Legally, the steps from this decision are: the Advisory Committee for the Definition of the Metre (chaired by a Canadian—Dr. L. E. Howlett, director of NRC's Division of Applied Physics) will send a report to the International Committee of Weights and Measures, which will meet in October of 1958; and from there to the International Conference on Weights and Measures, which was set up by treaty in 1875, and which meets every six years. At the next Conference, in 1960, the new standard will become legal in all member countries.

In practice, however, scientists will use this standard immediately. They have waited long enough for a standard of length that will not change, cannot be lost, and is available anywhere in the world. The new standard metre is 1,650,763.73 times the chosen wavelength of krypton 86. It is over 100 times more precise than "M", the 75-year-old bar of metal.

Canada's legal position will not be changed: since 1951, the Canadian yard is defined by law as 0.9144 International Metre, which makes the inch exactly equal to 25.4 millimetres.

A hundred millionth of an inch more or less may seem of academic interest alone; but in fact it is also practical. Modern industry is demanding higher and higher degrees of accuracy.

To an old-time mechanic, meeting a tolerance of a one-thousandth part of an inch was an achievement. Today, a ten-thousandth is common practice, and the master gauges controlling interchangeable manufacture are measured in millionths of an inch. The accuracy of these gauges is maintained by checking them against the best available standards. These master gauges, more than any other single factor, made mass production possible. Who knows what will come from two or more decimal places of precision?

Canada's standards of length and mass, as well as of heat, light, magnetism, electricity, and other forms of energy, are all maintained in NRC's Division of Applied Physics.

Canadian Developments

NEWS OF MAJOR ENGINEERING DEVELOPMENTS IN CANADA

St. Lawrence Seaway and Power Project

Though October weather was mild and mainly dry, completions or near-completions on some sectors of excavation and of concrete placing had reduced overall employment well below August and September peaks by month end.

Progress by Ontario Hydro

With 85 per cent of the concrete placed on the Canadian half of the international power-house, Ontario Hydro expects to have reached 90 per cent completion by year-end. The intake structure was built to full height opposite four units. No start had been made on installation of intake gates, but installation of taintor gates for the ice sluice was under way. Curtain grouting was proceeding, with completion expected by mid-December. Intake gate hoists were complete and tested. All draught-tubes were completed.

The smaller power-house crane had been tested, and installation of the large 300-ton power-house crane was nearing completion. Turbine speedrings were set for thirteen of the sixteen units. Wicket gates were placed for unit No. 1 and the runner was being installed.

With all the 5 million cubic yards of earth fill in place for the Cornwall dike, work continued on placing of riprap, with December 1 the target for completion. At the Galops Island cut the lower and upper confferdams had both been breached. Water level had been raised 3½ feet and the Iroquois dam was regulating the Lake Ontario level. There still remained some dredging and excavation to be completed.

Total employment by Ontario Hydro had been reduced to 5,100 persons by the end of October.

Progress by NYSPA

On the American half of the international power-house, placing of concrete had attained 85 per cent of completion. In contrast to the winter shut-down on concrete placing last year, smaller pours will be carried on this winter. All 16 draught-tubes were completed and four intake structures were built to full height. No installation of intake gates had been started. Curtain grouting of the foundation was completed.

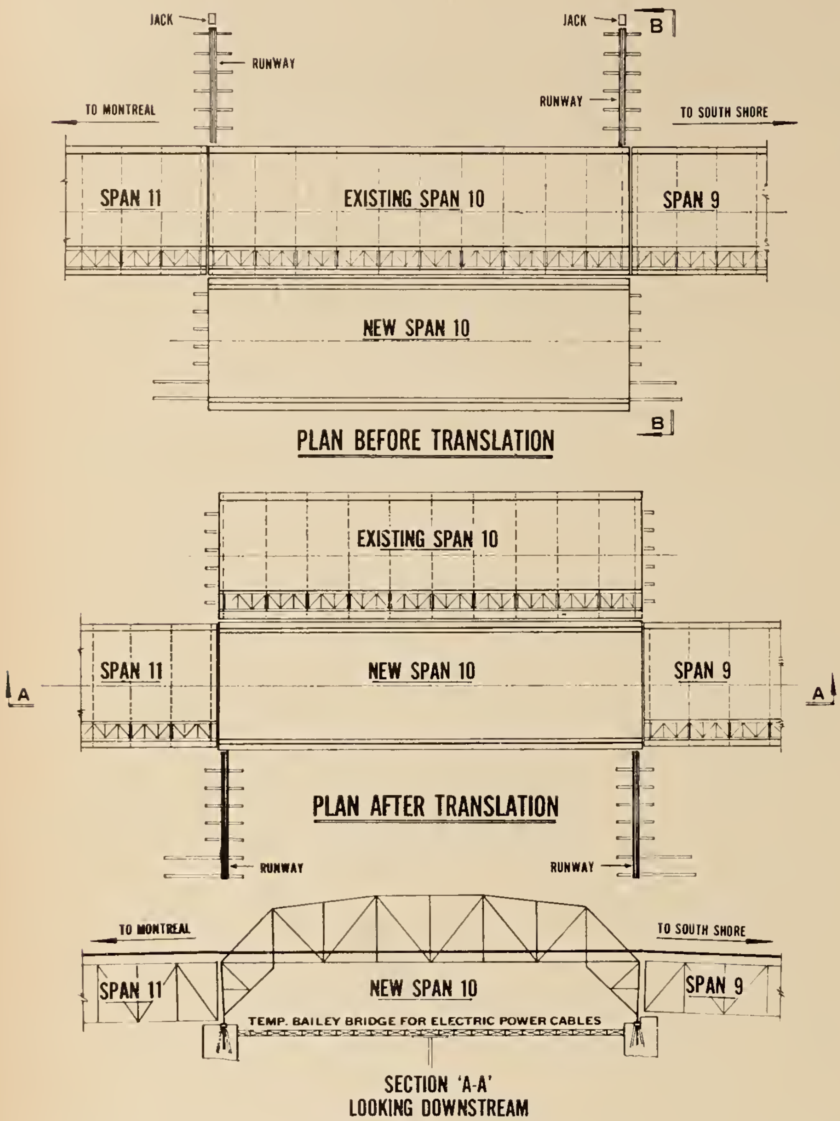
Installation and testing of the gantry crane and intake hoists had been completed. Installation of taintor gates for the ice sluice was under way. Ten of the 16 speedrings were set. Turbine wicket gates were installed for two units. One turbine runner was placed and setting of lower bearing was proceeding.

Excellent progress was made during October at the Long Sault dam, with some 570,000 cubic yards of concrete or more than 82 per cent of the total placed to date. All 16 rollways were poured to full height on the second stage, leaving only six of the entire 30 across the dam to be completed. The bulkhead section was nearing completion. Installation was proceeding on the roller gates in front of the tunnel for the 'second stage' for use next summer. Installation of the fixed hoists had not been commenced. In about another month's time cofferdam EI in stage 2 will be breached.

With the Iroquois dam practically completed, both up-and down-

Iroquois dam. Final stages of construction in progress include removal of the stage II cofferdam.

Jacques Cartier Bridge, Montreal, Translation of Span 10



General Information

Length of span between runways	245 ft.
Centre to centre of trusses on new span	66 ft.
Centre to centre of trusses on old span	40 ft.
Width of roadway on new span	60 ft.
Width of roadway on old span	48 ft.
Height of underside of new span above channel bottom	140 ft.
Length of travel	78 ft.
Total length of runway	220 ft.
Weight of new span	1,600 tons
Weight of old span	1,500 tons
Total weight moved	3,100 tons

The new and old spans were coupled together and mounted on eight roller trucks each containing forty-two 6 in. diameter rollers.

These trucks travel on two runways, each consisting of seven rails and are pulled through a chain of links by double acting hydraulic jacks, one of which is located at the downstream end of each track.

The jacks have a combined capacity of 500 tons and a stroke of four feet. Links are removed after each stroke, the jacks are retracted, reconnected and the process repeated until the translation has been accomplished.

The power is supplied by electrically driven hydraulic pumps delivering oil at pressures up to 6000 lb. per square inch.

Consulting engineer is Dr. P. L. Pratley, M.E.I.C. Dominion Bridge Company Limited is in charge of the bridge project.

stream cofferdams had been breached and were being removed, while installation of the crane was being checked. Clean-up is expected to be done by January 1. Clearing of the park area will be continued throughout the winter months. Employment on all NYSPA operations had dropped to approximately 5,000 by end of October.

Progress by SLSDC

With all concrete placed on both American locks, installation of gates by end of October had reached about 50 per cent of completion at the Grasse River lock and 25 per cent of completion for the Eisenhower lock. Excavation for the Long Sault canal (mainland section) had reached 97 per cent of completion, with the remaining half - million yards expected to be removed by about mid-December. Dikes had all been completed with exception of two gaps for temporary railway spurs.

Dredging of the Cornwall Island south channel, as well as completion of the two locks and the Long Sault canal, to permit 14-foot navigation by July 1, 1958 at which time the head pond above the power-house will be raised, was believed to be assured.

On the new international high-level highway bridge which replaces the existing highway-New York Central bridge at Cornwall, trestles over the dry-land section were completed. The north main bridge pier was nearing completion and the south main pier was 50 per cent poured, with completion expected in December. Employment on all SLSDC work had fallen to some 2700 persons by end of October.

Progress by SLSA

The upper Beauharnois lock was 45 per cent completed as to concrete placing; in October 43,000 cu. yd. were placed, making a total of 132,000 cu. yd. to that date. Rock and earth excavation figures were 72,000 yards, and 18,000 yards for the month, with totals to date of 1,070,000 and 533,000 yards.

Concrete placing for the lower Beauharnois lock was 60 per cent completed; 32,000 cu. yd. were placed during October, for a total to date of 190,000. Rock and earth excavation completed there amounted to 870,000 yards, and 67,000 yards.

At Cote Ste. Catherine lock, at end of October, 1.5 million yards of rock and 2.25 million yards of earth had been excavated. Concrete placing was 76 per cent completed—a total to month end of 313,000 cu. yd., of which 30,000 cu. yd. were placed in October.

The St. Lambert lock was 97 per cent completed; concrete poured in October was 32,000 cu. yd., for a total to month end of 460,000. Two million yards of rock excavation had been completed at month end, 113,000 yards during the month. A start was made on erecting stoplog derricks.

On the Iroquois lock, with gate installation nearing completion, both cofferdams breached and stoplogs in place at both ends, the lock was expected to be ready for 14-ft. navigation by about November 15. This will permit down-bound vessels to use the new lock instead of using the river channel, thus easing congestion at the end of the navigation season.

Dredging of the north Cornwall channel was continuing with one dredge working and excavation proceeding elsewhere, with no strict schedule for this operation.

Bridges

The Dominion Bridge Company started work in October on the lift span of the Victoria bridge at the St. Lambert end. The old roadway is being demolished and traffic is being diverted over new approaches.

Temporary approaches to the Honore Mercier bridge are in place and being used by traffic. Building of the piers of the bridge substructure is well under way.

Dominion Bridge Company, has started assembly of the falsework for the superstructure.

The C.P.R. bridge at Caughnawaga is proceeding, with erection of the south east tower and lift span girders started.

After installation of a through span on the Jacques Cartier bridge in a remarkable "translation" operation in October, the Dominion Bridge Company proceeded with the work of jacking up the bridge spans gradually into final position.

The two seaway authorities announced on October 16 that they had acquired all the shares of the Cornwall International Bridge Co. Ltd., which operates the Roosevelt bridge between Cornwall and the U.S. mainland. The bridge which carried both motor and rail traffic, ceased to carry New York Central traffic after February 15 this year.

The south channel section must be removed and the new high level highway bridge costing some $7 million will take its place, and will provide a 120 ft. clearance for vessels plying the seaway. Pending erection of the superstructure by SLSDC, a temporary ferry crossing will be provided to assure uninterrupted traffic over this international crossing.

Seaway Tolls

Notwithstanding preliminary indications to the contrary, Washington and Ottawa are said to be quite close together on the question of seaway tolls. While Canada would prefer to maintain the tradition of a free canal system, tolls were part of the bargain when the Americans agreed to share the seaway job. Rather than do the whole project alone, Canada agreed to go along with U.S. legislation and accept tolls.

Both seaway authorities themselves are agreed on the essential principle that tolls shall be low enough "to move the traffic", thus too low to protect Atlantic ports from competition. Considerable negotiations will yet be needed to determine exact levels of tolls and methods of measurement, but in broad outline the situation is capable of solution.

Operation, interest and sinking fund will cost some 25 to 28 million dollars annually. A fair and moderate toll on traffic, now in sight may earn some $20 million yearly. For the first few years the two governments will thus have to share annual deficits of between $5 and $8 millions a year. But when full operation and traffic develops it will not take many years to pay this back.

Today Canada has veto power. If the U.S. insists on tolls to pay carrying charges in full from the start, Canada can complete an all-Canadian seaway. Canada's position is so obvious to both sides that there is little chance threats may be necessary.

Canadian Pipeline Projects

Pipeline construction in 1957 is the outstanding feature for Canada's petroleum industry in a year of declining growth in production and refining and an actual volume decline in exploration and drilling. With over 5,000 miles of pipeline due for completion before year-end under existing contracts, total new capital investment for pipelines will exceed $650 million. Most spectacular has been the expansion of natural gas pipeline construction, which has accounted for over 2,000 miles of mainline and gathering systems and at least 2,500 miles of city and town distribution systems, including individual customer service.

Main gas line work for the year will include 192 miles of 30-inch pipe for Westcoast Transmission and 360 miles of 12-inch to 6-inch for Inland Natural Gas. The first stages for Westcoast's gathering system add 150 miles of line in diameters from 26 inch to 12 inch. First stage of Alberta Gas Trunk Line adds 100 miles of 18-inch, and 18 miles of 34-inch pipe. Across Saskatchewan and Manitoba Trans Canada accounts for 360 miles of 34-inch main line. Northern Ontario Crown Corporation will finish a substantial portion of the remaining 310 miles of 30-inch pipeline into Lakehead cities.

Further east Trans Canada will add 310 miles of 20-inch main from Toronto to Montreal and a 36 - mile branch to serve Ottawa-Hull. Union Gas will probably complete 150 miles of main from Dawn storage fields to Hamilton, while a further 24 miles will connect the Niagara Gas Line with Trans Canada, from which imported gas will be drawn pending arrival of Alberta gas.

Crude oil pipeline mileage in 1957 is small only in comparison to gas line mileage, as more than 800 miles will be laid including 156 miles of Interprovincial's extension to Port Credit. The balance of the oil line mileage was entirely looping programs and includes 100 miles of 30-inch for Trans - Mountain, 75 miles of 16-inch for Westspur, 32 miles of 16-inch for Pembina and 32 miles of 24-inch for Interprovincial.

Westcoast Transmission and Inland Natural Gas

Peace River gas was turned into the Westcoast system by British Columbia's Premier Bennett on October 8, by means of a remote - control unit in Vancouver, releasing an initial flow of 60 million feet daily. Ultimate capacity of the system will be 600 million cubic feet per day.

British Columbia Electric has signed a firm commitment for additional supply of Westcoast gas for Vancouver and the lower mainland distribution system. Volume will reach a maximum 144 million feet daily by 1961 for new thermal - electric power plants. Vancouver area customers for natural gas now number 30,000 compared with 5,500 previously on manufactured gas.

By mid - October the 875-mile Inland gas system was on the verge of completion less than 12 months after the first brush was cleared from the right of way. The project has been described as 'the toughest pipeline job in Canadian history', particularly the 40 miles of 10-inch line which crosses the continental divide over the Cascade Range, never before crossed by a pipeline in either Canada or the United States.

The final tie-in weld on the whole 875-mile system was made on October 7. Plans are already made to extend the system to 13 more communities in 1958, to bring the total up to 40. Total cost of capital installations so far is $25 million.

There are 377 miles of main line and laterals. Laterals and town distribution systems account for the remaining 498 miles. Territory served is generally a high fuel-cost area, and initial volume for the first heating season is calculated at a maximum daily demand of 20 million cubic feet daily for a total of almost 6 million cubic feet per day in the year ending October 31, 1958. Total population of the region served is approximately 110,000.

Alberta Gas Trunk Line

Extremely dry weather speeded 1957 construction on the first stage of the AGTL gathering system. One hundred miles of 18-inch pipe and 18 miles of 34-inch pipe from Bindloss junction to Burstall (where gas is delivered to Trans Canada) were laid in six weeks between late June and early August. The Provost field gathering system was completed in July. Future construction is undecided, since as yet no potential traffic estimate can be forecast for Trans Canada. Tentatively the 1958 schedule calls for a 75-mile line to tie in the Pincher Creek field with the system. Signed commitments of gas from the foothills area to the newly proposed Alberta Southern pipeline to California may necessitate substantial revisions to schedules. An extensive gathering grid for Alberta-Southern has been designed, for construction and operation by AGTL when the pipeline is approved.

Trans Canada Pipeline

With natural gas being delivered to Regina, Brandon, Portage la Prairie and Winnipeg since late in September, attention was focussed in October on progress between Winnipeg and the Lakehead. East of Winnipeg long stretches of floating muskeg and soft swamp have been encountered, as well as craggy rock of a very hard granite formation. While pipe laying will be completed to the Ontario boundary by the end of October, the Northern Ontario Pipeline Crown Corporation have been fighting Precambrian granite and the deepest and most fluid muskeg in Canada, as well as very wet weather. In spite of the use of many novel devices in an effort to complete the 310-mile stretch to Lakehead before freeze-up, all the tie-ins and backfill will not be completed before winter shuts the work down.

Near Mortlach, Sask., a 2,000-foot length of the Trans Canada line was destroyed by explosion and fire in early November.

Winnipeg and Central Gas

In September the Manitoba Public Utilities Board approved a rate of $1.03 per thousand feet for space and hot water heating in Winnipeg. Great Northern Gas Utilities, which serves 61 communities in Canada, including Brandon, and Great Plains Gas Co., a local company recently organized, have offered to distribute gas at undisclosed rates possibly up to 20 per cent lower than the $1.03 approved for Winnipeg and Central.

Winnipeg and Central in 1953 acquired the gas rights of Winnipeg Electric. Trans Canada is the only source of gas for the area and has undertaken to sell solely and exclusively to Winnipeg and Central, who have spent some $5 million laying new distribution lines in the metropolitan area. The company is a going concern, serving 20,000 customers and a projected 60 to 90 thousand in the future. Gas experts watching the situation say it is unthinkable the province would default on a contract established in 1880 and reconfirmed only four years ago. They predict Winnipeg and Central will continue to serve the greater Winnipeg area.

Alberta and Southern Gas Co. Ltd.

This company had signed contracts for 80 per cent of the available natural gas in the Pembina area by the end of October, on agreements to run 27 years. Studies indicate Pembina can supply up to 65 million cubic feet daily. The company has also completed a deal with Shell Oil Co. for production of 200 million feet daily. It is already making plans to build gathering and transmission systems as soon as approval is given by the Alberta Conservation Board.

Pembina gas will be sold to Northwestern Utilities Ltd. and Canadian Western Natural Gas Co. Northwestern will soon apply to the Board for permission to build a 75-mile line from Pembina to its distribution facilities in Edmonton. These two established gas utilities, associated as they are with Alberta and Southern, will provide an immediate market and will guarantee an assured supply to Alberta consumers because the province will have a prior call on all the gas it gathers before export.

U.S. Coalmen out to Halt Gas Import

Spokesmen from every segment of the U.S. coal industry have demanded of the U.S. State Department that Canadian gas be kept out of the United States. Their target is prevention of Tennessee - Midwestern from importing 204 million feet daily from Trans Canada, the case that has been before the Federal Power Commission for 18 months. Early in October, 12 spokesmen for the coal industry, the UMWA, the railroads and the coal distributors voiced their opposition to gas imports to Under-Secretary of State Douglas Dillon.

Representative Pat Jennings of Virginia said recently, "opening fuel markets to an alien product would certainly be unfair to members of the UMWA in the affected areas. It is a matter that requires the close attention of all members of Congress". The appeal to the State Department is a preview of what is expected to happen on the floors of the House and Senate when Congress starts its 1958 session in January.

Pipeline News

Activities of Distributing Utilities

Dominion Natural Gas has spent $500,000 of its $2 million expansion program, will continue through the winter months, extending services to St. Catharines, Thorold, Merritton, Fonthill and townships of Pelham and Grantham. 37,000 feet of 8-inch and 10-inch high pressure feeder lines have been laid. Gas supply will be boosted later this year with gas from

Texas, pending arrival of Alberta gas.

Lakeland Natural Gas is proceeding rapidly, with crews at work in Cornwall, Port Hope, Belleville and Gananoque, ready for a turn-on of gas by early in 1958, when an interim supply from Trans Canada will be available.

Consumers Gas Co. of Toronto showed a net profit of 82 cents a share for fiscal year ending September 30, an improvement over the previous year despite major rate reductions. Capital expenditures in 1958, in spite of the tight money situation, will be between $10 and $15 million. Work on the 33 mile pipeline north of Newcastle to serve Lindsay is scheduled for completion the end of October. Laying of distribution lines in Lindsay is being commenced.

Quebec Natural Gas Corp. will multiply sales volume of gas distributed about ninefold during the next four years to a total of 36 billion cubic feet by 1962. Seventy - five per cent of this volume will be required for new industrial services, including gas use as a derivative for chemical and petrochemical industries. It is estimated space heating customers will grow in number to 100.000 from the present 'restricted' 2,400.

Trans Canada May Double Output

Trans Canada President A. P. Craig forecasts the company's presently planned facilities will have to be doubled by 1961 or 1962. Every foot of gas contracted for from western producers has been sold under firm contracts. In view of this huge potential market, much larger than anticipated, he warned it would be well now for governments to go slow on further gas export commitments for another three or four years.

Royal Commission on Energy

Prime Minister Diefenbaker in mid-October announced the appointment of a six - man Royal Commission chaired by Henry Borden, president, Brazilian Traction, to recommend a coherent national policy on the use and export of all forms of energy. The move, involving an investigation lasting many months, is seen as an effective move to take the pipelines out of politics as well as an answer for the C.C.F. policy of nationalization.

The Commission's assignment is to study the creation of a national energy board able to regulate all forms of energy in co-ordinated fashion, as outlined by the Gordon Commission. Its terms of reference cover: best export policy to serve Canadian interests, national policy on rates, prices and financial structure of oil and gas pipeline companies.

Recent decision by British Columbia Electric to use Peace River gas for thermal generation of electricity exposes the absurdity of treating export of electric power in a different way and under different authority from export of oil and gas. Canada might do better to use its gas at home even to generate electricity for export. Canada would get a higher price for electricity than for gas, and more processing would be done in Canada.

The Commission will also investigate the special position of Trans Canada, as to whether special measures are required to be taken to safeguard the interests of producers or consumers of natural gas.

FPC Ruling May Hurt Trans Canada

An interim decision by the Federal Power Commission announced in mid-October, granted a conditional permit to a group of American Pipeline Companies to serve two big industrial markets in Chicago on which Trans Canada Pipelines was depending for about half its volume of supply for export. The gas, to be drawn from the reserves of the Pacific Northwest system by reciprocal interchange with Colorado Interstate and Natural Gas Pipelines of America, will supply the two largest steel mills in the Chicago area.

The decision, to be operative November 9, if not appealed, amounts virtually to dismissal of the Midwestern case, still under consideration by FPC, without FPC having to make a formal order to this effect. Granting of this permit to American Pipeline Companies, coupled with the establishment of the Royal Commission on Energy, will mean that Canada, and particularly Trans Canada Pipelines, is not likely to find export markets for its gas as readily as had been hoped a few months ago. The Royal Commission's investigations will delay any basic decisions on energy export till next spring or later, even as far as giving a company assurance it will be allowed to export and, if so, how much.

New Cable Cooling Technique

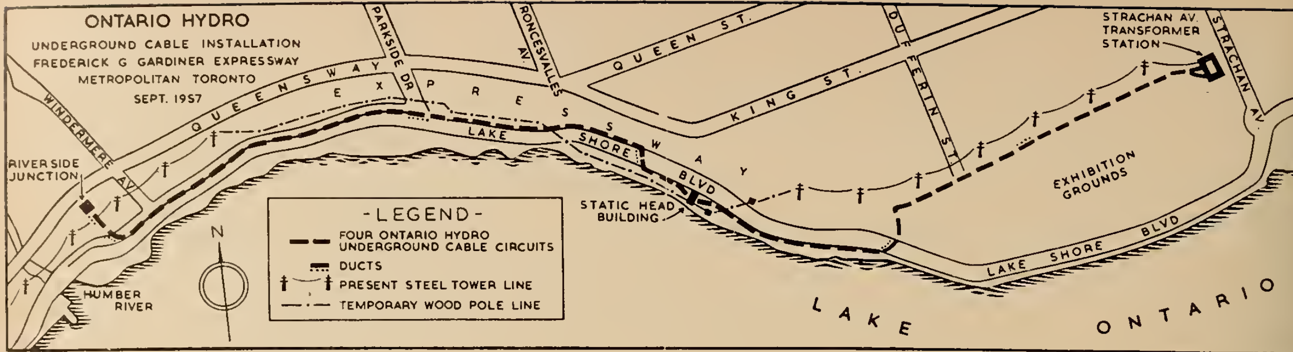
The building of the Metropolitan Toronto's new Expressway necessitated removing from the right of way thirty-one Ontario Hydro steel towers carrying transmission circuits.

Ontario Hydro's facilities in the Humber River-Strachan Avenue Section of the Toronto Lakeshore are being replaced by underground transmission equipment, employing a new system for cooling underground oil-filled cables developed by Ontario Hydro. The method may result in an increase of up to 50 or 60 per cent in the power carrying capacity of the four 115,000 volt transmission circuits completed in November.

The problem is that power being transmitted through cables heats them, and the temperature remains high wherever the cable passes through soil with low heat conductivity. Thus the amount of power which may be transmitted is limited by "hot spot" sections where soil conditions are resistant to transfer of heat. It emerged from studies that cold water pipes installed beside the underground circuits would overcome the temperature problem.

Polyethylene water piping was chosen as virtually immune from corrosion. Its installation was synchronized with that of the oil filled cable. The engineering was done by Ontario Hydro.

Two polyethylene pipes, with an inside diameter of three quarters of an inch, were laid with each set of three cables. The relation of this piping to the cable can be readily demonstrated by using zero symbols, the large one representing the cable and the small one, the polyethylene piping. They are placed in the trench as follows: 0o0o0. Under roadways and a railway embankment, however, the three-quarter-inch piping was too large to fit into the asbestos-type ducts which encase the cable at these points. As a result it was necessary to use six lengths of half-inch polyethylene piping, two lengths being encased with one cable in each duct to provide the required cooling. Special attachments are used at both ends of each set of ducts to connect the six lengths of the half-inch piping to the two lengths of the three-quarter-inch piping.



When placed in operation, the cooling system will utilize water from municipal mains. At every 1,600 to 2,000 feet, the water will be discharged into sewers and a fresh supply will flow into the piping. Experiments indicate that water discharged will be only 10 degrees warmer than when it enters the piping. At both intake and discharge points special fittings are used. Plans now being formulated point to "automation" being applied in the operation of the system. Thus, when the temperature of the cable rises to a certain point, the water in the piping, activated by electronic controls, would start to flow, carrying away the excess heat from the adjacent cables, thus reducing their temperature. When the safe operating temperature has been induced, the flow of water automatically stops.

Oil, under a static head pressure of approximately 15 pounds to the square inch, is within the hollow half-inch core of the copper conductor right from the time the cable is made. This pressure is maintained by portable equipment at all times until cable-laying and jointing operations have been completed. Thereafter, the pressure is provided by special oil tanks at suitable elevations. A set of 12 of these tanks, one for each cable, is located at the Riverside Junction point where the overhead transmission lines from the west are connected to the underground cables through 12 potheads, each of which stands about 15 feet above the ground. The oil tanks are located immediately above the potheads. At the eastern termination point, at the Commission's Strachan Avenue transformer station, there are similar sets of pot-heads and oil tanks. Owing to the variation in the contour of the cable route, it was necessary to establish intermediate sets of oil tanks. These are located within a tall, tower-like brick structure, known as the static head building.

Inside this structure, on the west, is a set of tanks at a low level, corresponding to the elevation of the tanks at the Riverside Junction. The set of tanks, at a high level, on the east side of the building, is at an elevation corresponding to that of the Strachan Avenue transformer station tanks. These two oil pressure systems coming together at this intermediate point are designed to overcome the difference in grade levels and thus maintain a constant pressure throughout the entire length of the underground circuits. This outward pressure from the centre of the copper conductor causes the oil to ooze through the very fine spaces between the strands of the conductor and to saturate the insulating paper, thus keeping out moisture and filling any voids.

The cable specified by Hydro for installation beside Expressway is described as the oil-filled type, having a copper conductor with a half-inch diameter hollow core. The insulation, as already indicated, is oil-impregnated paper which is covered by a metal sheath. The sheath, in turn, is covered with a coating of rubber bitumen and the latter is protected by tightly-woven jute wrapping. The overall diameter of the cable is approximately three inches and it weighs 10.4 pounds per foot, which means that over 1,000 tons of cable will be required for the entire project.

Of far-reaching significance in the power utility field this method is expected to play an increasingly important part as time goes on, making it possible for the underground cables to transmit greater amounts of power as demands increase. Without the cooling system, each of the four circuits now being installed is designed to transmit 140,000 kilowatts of power at 115,000 volts. This represents a total of 560,000 kilowatts for all four circuits operating at capacity. To attempt to transmit additional power without employing some method of cooling would cause the cables to heat up beyond the maximum safe temperature. As already pointed out, the new cooling system is expected to increase the power-carrying capacity of these particular circuits by at least 50 per cent. This means that, when required, these four circuits combined may be able to carry something like an additional 300,000 kilowatts.

What Goes On

On November 19, the first train travelled the completed C.N.R. line linking the Heath Steele Mine with Bartibog, N.B., 23 miles away, and thus with the rest of Canada, the United States and the Atlantic seaboard. Cost of the spur line to this promising mining location was approximately $3 million.

This is the third time in two months that C.N.R. has figured in ceremonies marking completion of railway lines reaching the new mining areas.

A special C.N.R. passenger train travelled from Winnipeg to Thompson, Man., on October 21, using the new branch line from Sipiwesk to Thompson. The rail link to the Mystery-Moak Lake area of northern Manitoba was built by International Nickel Company to serve its giant mining development but it is being operated by C.N.R.

The longest of the branch lines, the 161-mile line from Beattyville to Chibougamau, in Quebec, was opened in November. This is the first section of a 294-mile loop. The second section, running from St. Felicien in the Lake St. Jean area, to Chibougamau, is now under construction.

There will be more detailed information in the next issue about all three branch lines.

(Continued on page 1934)

Month to Month

News of the Institute and the Profession

COMMENT
CORRESPONDENCE
ELECTIONS
AND TRANSFERS

The Forty-Eighth Branch

On the afternoon of Thursday, September 19, a new branch of the Institute was inaugurated at Seven Islands, Quebec.

President of the Institute, C. M. Anson was at Seven Islands to present the charter to the new chairman, B. M. Monaghan. At the inaugural meeting there were about fifty engineers present and the branch certainly was off to a good start.

The program to celebrate this important occasion lasted for three days and included a visit to the iron ore mines at Knob Lake.

About twenty-five councillors came from a great variety of places to wish the branch good fortune and to attend the regional meeting of Council which was held on the afternoon of Friday the 20th. The Iron Ore Company brought all their engineers from the Knob Lake area to Seven Islands for the occasion and as well there was a substantial delegation from Baie Comeau.

The Institute is greatly indebted to the Iron Ore Company of Canada and to the Quebec North Shore & Labrador Railway Company and also to the Municipal Council. Between them they provided receptions, dinners, evening entertainment and special transportation by private plane on several occasions.

The outstanding feature of the program was the visit to Knob Lake. The engineers from that area returned by train on Friday and some of the visitors from other areas accompanied them on that journey. It is too bad that more could not have taken in the train trip because it really is something outstanding, but as far as most were concerned, time did not permit.

Flight over Northern Quebec

The main group flew from Seven Islands on Friday night aboard a D-C-3 getting to Knob Lake a bit before midnight. The flight up was a most unusual experience. The night was clear and the northern lights were brighter than anyone on the plane had seen them before. The thousands of small lakes just seemed almost to cover the landscape and were all shining like silver and the various lights on the railway line added their colour to the picture. The flight of the plane very closely paralleled the railway line which added much to the whole experience.

Overnight the guests were billeted in the guest house and in the local hotel and all gathered together the following morning for the trip through the various mines.

Saturday morning broke clear and sharp and all cameras were out snapping even before breakfast and they seemed to continue throughout the day. Better atmospheric conditions for photographs could never exist.

To this visitor the trip around the mines was unusually interesting because it enabled him to make a comparison with conditions as they were four years ago when first he and the then president of the Institute visited that area. The development is something colossal and must be seen to be appreciated. Even then, it is difficult if not impossible for the eye and the mind to comprehend the area of the activities.

Saturday afternoon the guests were flown back to Seven Islands and shortly thereafter were enplaned again (with box lunches) and flown over to Mont Joli where they picked up the train which returned them overnight to Montreal.

The presidential party and the visitors from Sydney stayed over Saturday night at Seven Islands and were flown out on Sunday to their various destinations.

Throughout the three days the weather had been perfect but it broke on Sunday and the plane which flew the party out that day was not able to get back into the airfield until two days later. It just shows how fortunate the Institute can be in these matters.

Branch Officers

The officers of the new branch in Seven Islands are:—

Chairman, B. M. Monaghan
Sec. Treas., Lawrence Fischer
Executive, R. W. Kenway
Marcel Michaud
Melville Storrier

The visitors who attended the Council meeting are as follows:

President C. M. Anson, Sydney, in the chair; Past Vice-Presidents R. L.

Cover Picture

The Queen Elizabeth Hotel, being built in Montreal by Canadian National Railways, is already a factor in the changing appearance of the city from the air, as the cover picture demonstrates.

Photograph courtesy Canadian National Railways

At Seven Islands, President C. M. Anson and Branch Chairman B. M. Monaghan.

Chairman B. M. Monaghan, I. R. Tait, Montreal, and Jean Menard, Rimouski.

Dunsmore, Montreal, alternate councillor, and I. R. Tait, Montreal, alternate councillor; Councillors B. O. Baker, Quebec, J. H. Budden, Montreal, C. H. R. Campling, Kingston, W. A. Devereaux, Halifax, C. E. Frost, Montreal, R. E. Hayes, Ottawa, G. E. Humphries, London, D. J. MacNeil, Antigonish, C. G. Southmayd, Montreal—representing the American Society of Mechanical Engineers; General Secretary L. Austin Wright.

The names of the persons on the charter for the new branch are as follows:

Emil Bodmer, A. D. Hamilton, J. J. Miller, B. Michael Monaghan, Charles G. Poulton, S. J. Simons, G. A. Verge, Pierre Bergeron, R. T. Giovannetti, Ross W. Kenway, Norman J. Lapierre, Marcel Michaud, Anthony Mousley, Melville Storrier, Fernand Talbot, Barrie Hall, Reginald W. Lowe.

Where Credit is Due

In such circumstances there is always one person who is principally responsible for the arrangements and the success. On this occasion it was B. M. Monaghan, M.E.I.C., assistant chief engineer of the Quebec North Shore and Labrador Railway Company. Mike was the inspiration, the organizer and the manager, surrounding himself with capable assistants as any good manager should do. To him go the thanks of all the visitors.

Throughout its lifetime, the Institute has had many "expeditions" of one kind or another but it is doubtful if any ever gave more pleasure to its participants than did this one. Long will Seven Islands and the hospitality of all its people be remembered by those who were fortunate enough to be present.

1957 University Registration in Engineering

For many years it has been the practice of the Institute to survey annually the enrolment of students in engineering at Canadian institutions. The report for this year, direct from 29 universities and colleges, will be found on pages 1840 to 1842 of this *Journal*.

As usual, the figures are interesting, and close examination of them will reveal some significant facts. Total enrolment in engineering courses in Canada shows an increase of 12 per cent, which is almost exactly the same rate of advance as one year ago. In actual numbers, 14,247 students are now studying engineering in some form, as compared with 12,723 in the fall of 1956. This should not cause any excitement, but it is still a good healthy increase.

Of more importance perhaps are the indications provided by the figures for the new freshman intake. These show an encouraging overall upward trend of 13 per cent, and the new classes of the Western universities have again stolen the spotlight. Registration in engineering in the four Western provinces has climbed rapidly in the last several years, at a faster rate than in the East, and we are now faced with the rather startling fact that this year 36 per cent of all freshmen engineers in Canada enrolled for study West of the Ontario-Manitoba border. Toronto, as expected, came up with the largest new class, 690 strong, followed by Alberta with 476, B.C. third with 473, and Saskatchewan next with 464. In all, 5132 new engineering students signed up in Canada this year.

If readers should compare the lists with those of a year ago, they will notice that some new names have been added. Canada now has four more educational institutions offering at least a partial engineering course of recognized standing. These four are Sir George Williams College, Montreal, McMaster University, Hamilton, Waterloo College, in Waterloo, and Assumption University in Windsor. The *Journal* welcomes them to the roster, and wishes their students and faculties every possible success.

The results from the Canadian Services Colleges again show a slight decline of 7 per cent in new registration. These are estimated figures of those cadets who will elect engineering after their second year, but they compare with last year on the same basis.

A comparison of the popularity of the different courses, as disclosed by the new survey, shows no important change. Civil remains first choice in total enrolment with 1935 students, followed by electrical with 1539, and mechanical showing 1355. This order is the same as last year, with electrical pulling away slightly from mechanical as compared with the 1956 figures. Interesting signs of the industrial times in Canada are given by the strong steady increases again this year in the numbers taking up studies in petroleum engineering and engineering physics.

As a forecast, and discounting casualties between now and next graduation, 2130 young engineers can expect to complete their courses and enter the profession in the spring of 1958. This will be a nice increase of almost 17 per cent over the previous figure, and is perhaps the brightest part of the picture. How far this will go toward filling the demand during 1958 will be watched with interest.

Confederation, Another View

The following article was written by John H. Fox, P.Eng., M.E.I.C. president of the Association of Professional Engineers of Ontario, for publication in the Association's *Professional Engineer*. At the request of the editor of *The Engineering Journal* Mr. Fox has been good enough to permit the *Journal* to publish it also. It speaks for itself.

During the months that it has been my privilege to write this column, there has been one subject that has not been discussed which should be of interest to all professional engineers. I refer to "confederation", or "Unity", of Canadian engineering associations and technical societies. First of all, it would be as well to attempt to define what is meant by "Unity". Such a definition, or description, could be that "Unity" would be the confederation of all Provincial Engineering Associations and Corporation, together with all technical societies in Canada, into a national body representative of, and represented by, its components to form an overall corporate body, to further the interests of all branches and aspects of professional engineering.

In passing, it may be stated that this is not a new project — but one that has been discussed for many years. It is a subject in which the general membership has only in recent years shown a wide degree of interest. Let us not forget that the provincial associations were fathered a generation ago by members of Canada's senior technical society — the Engineering Institute of Canada. At that time, legislation or the lack of it seemed to cramp the full scope of the profession. To-day we are faced with wider concepts and a need to move forward again.

Presently "Unity" centres around, and in discussion usually refers to, the unifying of the services of the Provincial Professional Engineering Associations and Corporation with those of the Engineering Institute of Canada. Each of these major groups has definite and distinct duties and functions to perform. Neither group should be expected to decrease or forego these functions and duties. A unified activity should enlarge the scope of each — without duplication.

The problems of how to accomplish the confederation are now under active review by committees of both groups, i.e. the Provincial Associations and E.I.C. These committees met and made certain recommendations which were not acceptable to all Councils. The committees were then re-formed to make further recommendations after more complete study in the light of instructions from the Councils. Together they work as a Joint Committee of both groups. I am convinced that real progress is being made toward the development of a procedure for the ultimate enlargement and consolidation of activities — of not only the Provincial Associations and the E.I.C., but of the other technical societies in Canada and branches of international engineering groups also.

"Unity" is a project large in scope and of tremendous challenge. It is hoped that local and self interest will not prejudice nor hinder decisions that can and must be made so that plans can be formulated and finalized. These are not local problems, they are not confined to the present generation, therefore expedience does not enter the picture. Decisions made now will influence the whole of the engineering profession in Canada for many decades to come.

Engineers' Civil Defence Forum

The second engineers' forum on civil defence brought thirty-one engineers to the Civil Defence College, at Arnprior, Ont., for five days starting September 16.

The aim of the forum, in all the various problems presented, was to demonstrate the need for engineer planning at all levels, as well as obtaining suggested solutions.

A report was submitted to this forum on the progress made with the recommendations of the 1956 forum. This showed that in some of the more important matters, most noticeably the formation of the Engineer Advisory Committee and its subsequent functioning, satisfactory headway had been made.

Recommendations of the Second Forum

In regard to shelter and refuge, the recommendations of this forum were: 1. That a simple guide to refuge assessment be drawn up; 2. that the engineer services, assisted by city assessors, etc., should be responsible for the assessment; 3. that the results of the assessment should be passed on maps and charts to the welfare services; 4. that protective factors should be included on city assessor cards.

It was agreed, that, in reception areas where there was insufficient refuge at the required standard, it was generally better to construct communal refuges, rather than to attempt numerous small improvisations.

Mobilization procedure was another major item of discussion. The forum was of the opinion that the engineer planning of mobilization should be commenced forthwith. In connection with this, they recommended that steps be taken to ensure that: 1. A legal requisitioning or payment plan be established; 2. The target city engineer should have control of all engineer resources within the target support area with effect from the completion of Phase "B", or the time of an enemy attack.

The forum agreed upon a sequence of operations for reconnaissance and planning after enemy attack—Phase "C" Operations. It was agreed that while small parties of engineers could be made operational with four hours, for small tasks of an extreme emergency nature, it would probably take up to 24 hours or more before the full engineer plan could be commenced.

It was recommended that engineer fire problems should be discussed and solved at provincial level. Since problems were so dependent on local conditions, it was felt that this procedure would bring greater progress in satisfactory planning.

"The Interim Guide to Engineer Planning" was examined and recommendations made for its improvement. It was to be issued shortly.

The detailed report of the forum can be referred to at the E.I.C. Library.

REGISTRATION IN ENGINEERING AT CANADIAN UNIVERSITIES

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Memorial	1st	86	....	....	....	....	....	....	....	....	....	....	....	....	....	....	86
	2nd	36	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36
	3rd	33	....	....	....	....	....	....	....	....	....	....	....	....	....	....	33
Total....		155	....	....	....	....	....	....	....	....	....	....	....	....	....	....	155
Dalhousie	1st	78	....	....	....	....	....	....	....	....	....	....	....	....	....	7	85
	2nd	65	....	....	....	....	....	....	....	....	....	....	....	....	....	3	68
	3rd	29	....	....	....	....	....	....	....	....	....	....	....	....	....	2	31
	4th	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5	5
Total....	....	172	....	....	....	....	....	....	....	....	....	....	....	....	....	17	189
St. Mary's	1st	43	....	....	....	....	....	....	....	....	....	....	....	....	....	....	43
	2nd	30	....	....	....	....	....	....	....	....	....	....	....	....	....	....	30
	3rd	26	....	....	....	....	....	....	....	....	....	....	....	....	....	....	26
Total....	....	99	....	....	....	....	....	....	....	....	....	....	....	....	....	....	99
St. Francis Xavier	1st	125	....	....	....	....	....	....	....	....	....	....	....	....	....	....	125
	2nd	87	....	....	....	....	....	....	....	....	....	....	....	....	....	....	87
	3rd	79	....	....	....	....	....	....	....	....	....	....	....	....	....	....	79
Total....	....	291	....	....	....	....	....	....	....	....	....	....	....	....	....	....	291
N.S. Technical College	4th	....	....	....	....	11	51	48	....	....	....	....	29	2	8	....	149
	5th	....	....	....	....	17	40	41	....	....	....	....	28	—	1	....	127
Total....	....	....	....	....	....	28	91	89	....	....	....	....	57	2	9	....	276
Acadia	1st	68	....	....	....	....	....	....	....	....	....	....	....	....	....	....	68
	2nd	58	....	....	....	....	....	....	....	....	....	....	....	....	....	....	58
	3rd	43	....	....	....	....	....	....	....	....	....	....	....	....	....	....	43
Total....	....	169	....	....	....	....	....	....	....	....	....	....	....	....	....	....	169
Mount Allison	1st	62	....	....	....	....	....	....	....	....	....	....	....	....	....	....	62
	2nd	70	....	....	....	....	....	....	....	....	....	....	....	....	....	....	70
	3rd	117	....	....	....	....	....	....	....	....	....	....	....	....	....	....	117
Total....	....	249	....	....	....	....	....	....	....	....	....	....	....	....	....	....	249
New Brunswick	1st	....	....	....	....	11	61	45	....	....	....	....	33	....	2	....	152
	2nd	....	....	....	....	11	75	70	....	....	....	....	23	....	3	....	182
	3rd	....	....	....	....	6	43	34	....	....	....	....	25	....	3	....	111
	4th	....	....	....	....	....	59	14	....	....	....	....	24	....	....	....	97
	5th	....	....	....	....	....	45	20	....	....	....	....	18	....	....	....	83
Total....	....	....	....	....	....	28	283	183	....	....	....	....	123	....	8	....	625
Laval	1st	150	....	....	....	....	....	....	....	....	....	....	....	....	....	....	150
	2nd	234	....	....	....	....	....	....	....	....	....	....	....	....	....	....	234
	3rd	....	....	....	....	12	44	23	....	....	....	5	17	5	2	12	120
	4th	....	....	....	....	6	27	25	....	....	....	5	16	4	8	10	101
	5th	....	....	....	....	13	34	26	....	....	....	5	16	6	8	6	114
Total....	....	384	....	....	....	31	105	74	....	....	....	15	49	15	18	28	719
Ecole Polytechnique	1st	273	....	....	....	....	....	....	....	....	....	....	....	....	....	....	273
	2nd	228	....	....	....	....	....	....	....	....	....	....	....	....	....	....	228
	3rd	174	....	....	....	....	....	....	....	....	....	....	....	....	....	....	174
	4th	....	....	....	....	5	45	....	....	68	....	3	....	6	3	....	130
	5th	....	....	....	....	6	44	....	....	56	....	6	....	10	6	....	128
Total....	....	675	....	....	....	11	89	....	....	124	....	9	....	16	9	....	933

REGISTRATION IN ENGINEERING AT CANADIAN UNIVERSITIES

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McGill	1st	365	....	....	....	....	....	....	....	....	....	....	....	....	....	....	365
	2nd	408	....	....	....	....	....	....	....	....	....	....	....	....	....	....	408
	3rd	....	....	....	....	33	75	68	....	....	....	....	61	12	9	25	283
	4th	....	....	....	....	46	73	74	....	....	....	....	62	10	5	15	285
	5th	....	....	....	....	36	62	76	....	....	....	....	71	7	11	14	277
Total....	....	773	....	....	....	115	210	218	....	....	....	....	194	29	25	54	1,618
Sir George Williams College	1st	58	....	....	....	....	....	....	....	....	....	....	....	....	....	....	58
Total....	....	58	....	....	....	....	....	....	....	....	....	....	....	....	....	....	58
Sherbrooke	1st	75	....	....	....	....	....	....	....	....	....	....	....	....	....	....	75
	2nd	55	....	....	....	....	....	....	....	....	....	....	....	....	....	....	55
	3rd	26	....	....	....	....	....	....	....	....	....	....	....	....	....	....	26
	4th	23	....	....	....	....	....	....	....	....	....	....	....	....	....	....	23
Total....	....	179	....	....	....	....	....	....	....	....	....	....	....	....	....	....	179
Ottawa	1st	....	....	....	....	13	12	22	....	....	....	3	6	1	....	....	57
	2nd	....	....	....	....	21	28	23	....	....	....	3	11	1	....	....	87
	3rd	....	....	....	....	13	10	10	....	....	....	....	4	....	....	....	37
	4th	....	....	....	....	6	....	7	....	....	....	....	....	....	....	....	13
	5th	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	3
Total....	....	....	....	....	....	56	50	62	....	....	....	6	21	2	....	....	197
Carleton	1st	41	....	....	....	....	....	....	....	....	....	....	....	....	....	....	41
	2nd	34	....	....	....	....	....	....	....	....	....	....	....	....	....	....	34
Total....	....	75	....	....	....	....	....	....	....	....	....	....	....	....	....	....	75
Queen's	1st	313	....	....	....	....	....	....	....	....	....	....	....	....	....	....	313
	2nd	....	....	....	....	31	50	50	....	....	....	17	53	7	11	12	231
	3rd	....	....	....	....	45	42	41	....	....	....	12	44	7	13	18	222
	4th	....	....	....	....	40	56	36	....	....	....	11	55	7	12	14	231
Total....	....	313	....	....	....	116	148	127	....	....	....	40	152	21	36	44	997
Toronto	1st	....	....	....	....	96	97	125	43	....	....	37	100	15	30	147	690
	2nd	....	....	....	....	55	92	96	45	....	....	26	68	15	21	112	530
	3rd	....	....	....	....	62	73	66	50	....	....	15	89	7	23	67	452
	4th	....	11	....	....	75	81	74	60	....	....	9	94	11	16	51	482
Total....	....	....	11	....	....	288	343	361	198	....	....	87	351	48	90	377	2,154
McMaster	1st	48	....	....	....	....	....	....	....	....	....	....	....	....	....	.	48
Total....	....	48	....	....	....	....	....	....	....	....	....	....	....	....	....	....	48
Ontario Agricultural College*	3rd	....	....	....	....	....	8	....	....	....	....	....	16	....	....	....	24
	4th	....	....	....	....	....	10	....	....	....	....	....	13	....	....	....	23
Total....	....	....	....	....	....	....	18	....	....	....	....	....	29	....	....	....	47
Waterloo College†	1st	174	....	....	....	....	....	....	....	....	....	....	....	....	....	....	174
Total....	....	174	....	....	....	....	....	....	....	....	....	....	....	....	....	....	174

* Students in Agricultural Engineering who will proceed to their final year in Mechanical or Civil Engineering at the University of Toronto on completion of their studies at Guelph.

† Course intake at Waterloo is on the "quarter system". The figure given includes up to September, 1957. Later intakes will have to be held over until the next tabulation.

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Western Ontario	1st	51	....	....	....	....	....	....	....	....	....	....	....	....	....	....	51
	2nd	40	....	....	....	....	....	....	....	....	....	....	....	....	....	....	40
	3rd	....	....	....	....	....	3	3	....	....	....	....	5	....	....	....	11
	4th	....	....	....	....	3	4	3	....	....	....	....	2	....	....	....	12
Total....	....	91	....	....	....	3	7	6	....	....	....	....	7	....	....	....	114
Assumption	1st	57	....	....	....	....	....	....	....	....	....	....	....	....	....	....	57
Total....	....	57	....	....	....	....	....	....	....	....	....	....	....	....	....	....	57
Manitoba	1st	355	....	....	....	....	....	....	....	....	....	....	....	....	....	....	355
	2nd	168	....	....	....	....	....	....	....	....	....	4	....	....	....	5	177
	3rd	....	....	....	....	....	59	44	....	....	....	8	45	....	....	5	161
	4th	....	....	....	....	....	39	35	....	....	....	3	62	....	....	3	142
Total....	....	523	....	....	....	....	98	79	....	....	....	15	107	....	....	13	835
Saskatchewan	1st	464	....	....	....	....	....	....	....	....	....	....	....	....	....	....	464
	2nd	257	....	....	....	24	....	....	....	....	....	....	....	....	....	....	281
	3rd	....	....	8	....	10	72	20	....	....	....	14	55	....	....	20	199
	4th	....	....	1	2	27	41	17	....	....	....	15	45	....	....	12	160
Total....	....	721	....	9	2	61	113	37	....	....	....	29	100	....	....	32	1,104
Alberta	1st	476	....	....	....	....	....	....	....	....	....	....	....	....	....	....	476
	2nd	....	....	....	32	68	136	54	....	....	....	....	....	2	4	1	297
	3rd	....	....	....	24	41	60	47	....	....	....	....	....	7	8	7	194
	4th	....	....	....	16	48	52	27	....	....	....	....	....	2	9	7	161
Total....	....	476	....	....	72	157	248	128	....	....	....	....	....	11	21	15	1,128
British Columbia	1st	469	....	....	....	....	....	....	....	....	4	....	....	....	....	....	473
	2nd	224	....	....	....	....	....	....	....	....	2	....	....	....	....	....	226
	3rd	....	....	....	....	16	47	55	....	....	1	15	61	16	5	33	249
	4th	....	....	....	....	22	28	50	....	....	5	11	57	11	1	25	210
Total....	....	693	....	....	....	38	75	105	....	....	12	26	118	27	6	58	1,158
Canadian Services Colleges																	
Royal Military College (Kingston)	1st	55	....	....	....	....	....	....	....	....	....	....	....	....	....	....	55
	2nd	43	....	....	....	....	....	....	....	....	....	....	....	....	....	....	43
	3rd	....	....	....	....	13	28	39	....	....	....	....	28	....	....	4	112
	4th	....	....	....	....	10	29	31	....	....	....	....	19	....	....	5	94
Total....	....	98	....	....	....	23	57	70	....	....	....	....	47	....	....	9	304
Royal Roads	1st	68	....	....	....	....	....	....	....	....	....	....	....	....	....	....	68
	2nd	66	....	....	....	....	....	....	....	....	....	....	....	....	....	....	66
Total....	....	134	....	....	....	....	....	....	....	....	....	....	....	....	....	....	134
Collège Militaire Royal de St.-Jean	1st	95	....	....	....	....	....	....	....	....	....	....	....	....	....	....	95
	2nd	66	....	....	....	....	....	....	....	....	....	....	....	....	....	....	66
Total....	....	161	....	....	....	....	....	....	....	....	....	....	....	....	....	....	161
Grand Total	....	6,768	11	9	74	955	1,935	1,539	198	124	12	227	1,355	171	222	647	14,247
Prospective 1958 Graduates	....	....	11	1	18	290	526	405	60	56	5	60	448	54	64	132	2,130

The Members Greet President C. M. Anson

President Anson made a tour of the Atlantic Provinces in September and October, and met many E.I.C. members at meetings, receptions, and other events.

At Halifax Mr. Anson (above left) visited Mayor L. A. Kitz at City Hall; he spoke to N.S.T.C. students and was photographed (above centre) with President J. Hoogstraten of N.S.T.C., and John Devlin, president of Student Society; he visited Col. F. W. W. Doane, senior member of the Branch and father of H. W. L. Doane, vice president (above right).

At A.P.E.N.S. luncheon (centre right): Mr. Anson, L. D. Wickwire, J. D. Kline, J. Hoogstraten, Dr. A. Cameron, past-president of N.S.T.C. Calling on the Lieut. Governor of Nova Scotia, Hon. Allister Fraser (right): Mr. Anson, G. H. Dunphy, Mr. Fraser, H. W. L. Doane, and R. D. Wickwire, chairman of the branch.

President Anson (left), with Albert Martin of Bowaters, at Corner Brook, Nfld.

At St. Francis Xavier University, Antigonish, D. J. MacNeil, chairman of the Branch, Mr. Anson, and Rev. F. J. Somers, president of the University.

Dinner meeting of the North Nova Scotia Branch marked the president's visit to New Glasgow. At the head table, Robert Morrow, Mr. Anson, Chairman D. J. MacNeil, Mrs. Anson, H. W. L. Doane, Mrs. Morrow, J. E. Clarke. Below right, the student audience at St. Francis Xavier.

At Charlottetown, the president signed the co-operative agreement between the Association of Professional Engineers of Prince Edward Island. and the E.I.C. (above): Mrs. Anson, C. W. Currie, Mr. Anson, N. F. Stewart, Branch chairman and Association president, and C. F. Buckingham. Above right: N. F. Stewart, Lt. Governor T. W. L. Prowse of P.E.I., receiving the president, Mrs. Prowse, Mr. Anson and Harvey Doane, vice-president. At supper: Mr. Doane, Mrs. Anson, C. W. Currie, Mr. Anson, N. F. Stewart, Mrs. Currie, Mrs. Stewart.

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President Anson (right), visiting Mayor J. David Stewart of Charlottetown, with Harvey Doane; and (at right) offering greetings to the premier of P.E.I., A. W. Matheson.

The members and the ladies everywhere offered a friendly welcome for Mr. and Mrs. Anson, (as below).

At Bathurst, President Anson visited the works of the Brunswick Mining & Smelting Company. In this group, G. P. Milton, R. C. Eddy, L. L. Marshall, L. Riggs, manager of the company, L. Austin Wright, and Mr. Anson. In foreground, D. Bent, mine superintendent. →

Dinner at Kent Lodge (above), G. P. Milton, Mrs. Eddy, Mayor R. J. Cormier of Bathurst, Mrs. Marshall, Mr. Anson, L. L. Marshall, branch chairman, Mrs. Anson, R. C. Eddy, councillor, Mrs. Cormier and Mrs. Milton.

The ladies entertained Mrs. Anson: Mrs. R. Esterbauer, Mrs. F. W. Buckley, Mrs. G. E. McLellan, Mrs. Anson, Mrs. L. L. Marshall.

↑ The president (left), with members of the interim committee of Baie Comeau Branch, V. M. Wallingford and N. A. Holloway.

The Moncton Branch staged a dinner for the president. At the head table, Mrs. Leighton, Mr. Stratton, Mayor M. M. Baig, Mrs. G. E. Franklin, H. W. L. Doane, Mrs. Anson, V. C. Blackett and Mrs. Blackett, M. F. K. Leighton, Mrs. Stratton.

Visiting city hall, Moncton: Mr. Anson, Mr. Doane, Mr. Franklin, branch chairman, Mayor M. M. Baig; at the Moncton engineering department: W. M. Steeves, acting city engineer, Mr. Franklin, Mr. Doane, Mr. Anson. →

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Mr. Anson took advantage of his visit to Sydney, N.S., to present to two members, W. S. Wilson, and Major C. M. Smythe, E.I.C. pins signifying attainment of life membership.

At Seven Islands, Quebec, inauguration of the North Shore Lower St. Lawrence Branch was the main event of the president's visit.

The photographs at right show an informal gathering at the Iron Ore company's guest house, Knobb Lake, and a portion of the inaugural branch meeting.

Below, members and guests attending the dinner meeting: while the identifications of the four groups are incomplete, those obtained are as follows: top left, Charles G. Southmayd, John Young, J. H. Budden, G. E. Humphries, R. E. Hayes, and others; top right, Mrs. Dunsmore, I. R. Tait, Mrs. M. Monaghan, C. M. Anson, H. R. Farnam, Mrs. Anson; lower left: Mr. O'Rourke, Mr. Frost, M. W. Martin, Mrs. Martin, C. H. R. Campling, Prof. O'Neil, J. Young, Mrs. C. N. Murray; lower right, B. Kelly, Y. L'Ecuyer, Mrs. L'Ecuyer, Marcel Michaud, Mrs. Michaud, Jean Menard, and others.

Elections and Transfers

A number of applications were presented for consideration and on the recommendation of the Admissions Committee, the following elections and transfers were effected on October 19, 1957.

Members: A. Baber, Montreal; W. R. Beamish, Montreal; R. T. A. Bolitho, Toronto; C. B. Crocker, Vancouver; G. O. A. Dahlstrom, Vancouver; P. Ebbehoj, Denmark; N. Foran, Montreal; I. F. Gilbert, Three Rivers; H. Grunwell, Windsor; R. I. Hamilton, Sault Ste. Marie; H. M. Hay, Asbestos; C. E. G. Holt, Cornwall; K. B. Jackson, Toronto; J. S. Logie, Vancouver; K. M. MacKenzie, Montreal; V. Maidaniw, Montreal; B. Nagy, Montreal; K. R. Olsen, Montreal; D. J. Pickering, Montreal; J. M. Reid, Calgary; J. Shepherd, Quebec.

Juniors: A. J. Alexander, Toronto; R. F. Barnard, Baie Comeau; D. J. Paines, Toronto; W. B. Taylor, Toronto.

Junior to Member: F. De Francis, Montreal; T. J. Hobson, Montreal; J. Kilgour, Toronto; C. Lacombe, Montreal; D. R Wilson, Montreal.

Affiliate: I. L. Sewell, Baie Comeau.

STUDENTS ADMITTED:

University of Ottawa: P. Arvisais; M. V. Ashkar; A. Aubin; J. V. Audette; L. Audette; A. Baril; C. R. Baron; A. Belanger; B. Bergeron; J. P. Bertrand; J. H. L. Bigras; G. Bisson; Y. Blanchard; B. Boileau; R. Boisvenu; A. Boisvert; F. Bouchard; J. L. Boucher; R. N. Bowes; D. Brady; J. J. M. A. Caron; G. F. Cataford; J. G. Cayer; Y. H. Chan; H. Charbonneau; P. J. Choquette; C. W. Chu; L. Y. Chung; G. J. T. Clark; J. Clay; K. R. Crouch; K. Csavinszky; C. D. Danis; P. E. De Breyne; G. De Carufel; P. Decoste; P. Demers; J. E. G. Drouin; R. M. Dubois; J. P. Durocher; Y. T. Fong; L. A. Fuller; E. Gagnon; R. Giguere; P. M. Gillis; R. Giroux; A. A. R. Groleau; D. M. Harris; I. Jean; W. J. L. Jette; P. J. F. Joncas; E. E. Kalogerakis; D. P. K. Kenny; L. Kolesar; C. Kwan; R. Lacroix; M. Lafontaine; F. J. Lapensee; J. Lecompte; G. Legault; J. P. Lepage; R. F. Lesperance; C. W. Leung; C. Levasseur; J. L. Mathieu; B. W. Matte; P. J. McCann; M. D. McCormack; A. A. McDonald; P. A. McNeely; P. D. Mercier; L. G. Millette; A. Nirchandani; N. Monette; W. J. Morin; A. Nadon; H. B. O'Connell; J. T. O'Connell; M. Parent; W. Pascal; G. Patenaude; H. M. Pedroso; R R. Philippe; J. Pigeon; R. K. Plowman; J. Poirier; T. Provencher; C. G. Quenneville; W. Quintanilla; G. R. Raymond; A. Renaud; R. Richard; R. J. Ross; M. Seguin; J. A. A. Serre; C. C. Simard; K. Smith; S. Tong; D. Tremblay; J. A. R. Trudel; J. M. Vaillancourt; R. D. Voyer; E. J. Zavitski.

University of Toronto: B. K. Bain; J. H. Dickinson; A. K. Englert; C. W. Grant; L. P. Green; F. J. Heatley; J. Lowry; J. C. McCartney; D. R. Miller; N. F. Peterson; G. J. Ryva; D. P. Rutenberg; O. G. A. Schmidt; J. R. Seedhouse; V. Smith; E. Yanchula.

Nova Scotia Technical College: S. Gonzalez A.; F. Klindt; Y. Kuri.

McGill University: M. P. Paidousis.

University of B.C.: D. E. De Courcy.

University of Sask.: D. G. McNabb.

Royal Military College: H. G. B. Hallas.

University of N.B.: A. J. W. Bate.

Mount Allison Univ.: M. E. Terceira.

Saint Mary's Univ.: M. S. Abularach.

Student C.P.E.Q.: D. H. Gray.

Graduates: J. W. Ryan, B.Eng. (Elec.), N.S.T.C., 1957. E. J. Borza, B.Sc. (Elec.), Queen's, 1957. E. W. Hoffmann, Dipl.Ing. (Elec.), Poly. Academy, Austria. E. J. Rowe, B.Eng. (Mech.), Clarkson College of Technology, 1957.

Applications through Associations

By virtue of the co-operative agreements between the Institute and the Associations of Professional Engineers, the following elections and transfers have become effective:

ALBERTA

Members: F. L. Hickey, M. J. Patrick, S. Venyi. **Junior to Member:** J. D. G. Wallbridge; **student to member:** W. M. Synhorst.

SASKATCHEWAN

Junior to Member: J. T. McManus, I. F. Rogers.

NOVA SCOTIA

Member: J. W. Farrell.

NEW BRUNSWICK

Junior to Member: M. P. Estey.

MANITOBA

Junior to Member: I. W. Fraser.

EJC-ECPD General Assembly

The head table at the EJC·ECPD general assembly banquet was a roster of the heads of engineering societies. Left to right, G. H. Dyer, president NSPE; G. B. Carson, president AIIE; H. A. Kaho, president SAME (not photographed); L. F. Grant, past-president E.I.C.; P. B. Gordon, president ASHAE; J. H. Rushton, president AIChE; W. J. Barrett, president AIEE; A. B. Kinzel, president-elect AIME; T. H. Chilton, past-president EJC; C. E. Davies, secretary ASME. The banquet was held at the Statler Hotel, New York, M. D. Hooven presiding. C. E. Davies was the speaker.

Head table at the EJC-ECPD General Asssembly Banquet, continued, *left to right*, M. D. Hooven, past-president ECPD; L. R. Howsen, president ASCE; W. F. Ryan, president ASME; F. C. Lindeval, president ASEE; F. Merryfield, president AWWA; R. G. Warner, representing NSBEE; H. F. Spoehrer, president ASRE; E. H. Anson, president AICE.

THIRTY-FIVE YEARS AGO

Comment on the Journal of December, 1922

Three technical papers, two presented before the Montreal Branch and the third before the Toronto Branch, were reproduced in full in this issue. P. Ackerman, M.E.I.C., electrical engineer, Shawinigan Water and Power Co., described a new principle of protection developed for his company's 50,000 volt 30 cycle transmission system. John Grieve, A.M.E.I.C., of Dominion Paint Works, had a paper entitled 'Paint as a protection for steel structures'. The paper, read in Toronto, had been presented by Owen W. Ellis, A.M.E.I.C., of the department of metallurgical engineering, University of Toronto, entitled "Points of Contact between Metallurgy and Engineering". Mr. Ellis invited members to enquire into the economics of certain alloys of aluminum for use in structural work, showing how savings in freight haul and erection costs and the avoidance of corrosion might enable these alloys to compete with structural steel. It will be recalled that only a few years later the first Canadian all-aluminum highway bridge was built in the Saguenay district of northern Quebec.

Editorially, it was noted that proposed changes in by-laws recommended by the Committee on Policy, relating to membership, fees, branch membership and nominations, etc., had been endorsed by Council. The election of C. E. W. Dodwell, M.E.I.C., one of the prime movers in the establishment of the Canadian Society of Civil Engineers, as an Honorary Member of the Institute was announced. Major George A. Walkem, (later to become a president of the Institute) was appointed lecturer in industrial management in the department of mechanical engineering, University of British Columbia.

Sixteen pages were devoted to Branch News, with reports of activities in as many branches. The Victoria Branch reported on an address by Major George Walkem on institute policy and legislation. The Edmonton Branch noted presentation of three short papers on railroad organization, the Alberta government telephone system, and on the possibility of smelting iron ores from the vicinity of Lake Athabaska in northern Alberta. The Lethbridge Branch heard a talk by A. M. Robertson, M.E.I.C., executive engineer of the Punjab, India, outlining construction and operations there on the government owned irrigation systems.

At Calgary, P. Turner-Bone, M.E.I.C., explained the underlying principles behind the system of proportional representation then being generally adopted in elections, with the aid of charts. At Winnipeg, Lt. Col. H. C. Boyden addressed the Branch on concrete highway investigations and specifications, both in Canada and the United States, summarizing recommendations for subgrades and concrete slabs.

The Hamilton Branch was addressed by Brig. Gen. C. H. Mitchell, D.S.O., M.E.I.C., dean of the faculty of applied science, University of Toronto, who outlined operations in the Italian campaign in the Alps between 1917 and the Armistice. Engineering problems such as tunnels, bridges and cliff galleries, were discussed with the aid of slides.

The Border Cities' Branch heard C. E. Goodrich, M.E.I.C., of Canadian Bridge Company, who gave an interesting talk, interspersed with humorous personal reminiscences, on the design of transmission towers. M. E. Brian, A.M.E.I.C., city engineer of Windsor, also entertained the meeting with his 'Reminiscences of a City Engineer'. In more serious vein, he counselled his fellow engineers to 'stop the criticism of their fellow engineers, but rather to boost them and place them on a par with the professions of law and medicine'.

F. C. C. Lynch, secretary-treasurer of the Ottawa Branch, probably the most prolific branch reporter of the day, reported in detail on an address to that branch by the Hon. J. A. O. Prens, governor of Minnesota, at a luncheon held in his honour by the branch, attended by Prime Minister Mackenzie King, cabinet ministers, diplomats and government officials. His subject was "The Great Lakes-St. Lawrence River Scheme". The speaker stated 4.1 million horsepower would be developed from the scheme, 3.1 million of which would go to Canada, while 34 miles of channel with locks and 182 miles of channel improvement would be constructed. The estimated cost would be $252 million, (or about a fourth of the actual cost today!).

General Secretary Fraser Keith addressed the Cape Breton Branch on October 31 on policy and on the procedure followed in handling the Institute's employment bureau, a matter of great interest to the outlying branches. Following his address, a Halloween dinner was held, and with the text a reproduction of the menu was given. Delicacies listed included — 'preliminary lubrication'; turkey (with worm drive); vegetables (fine aggregate, coarse aggregate, conglomerate); pie (plastic inclusions); beverages (low potential juice); fruit (ball bearings), nuts and washers; cigars (gas producers).

The foregoing cross-section of branch activities, though not a complete record, gives today's membership a backward peek at the subjects of interest to engineers in the late 'twenties'. The lists appear heavily weighted with subjects relating to civil, mechanical and electrical engineering subjects. A comparison with the subjects discussed at branch meetings today, — atomic energy; electronics; chemical engineering; petrochemicals; aircraft production; aviation; economics; pipelines; telecommunications; radio and T.V.; provides a measure of thirty five years development of the profession of engineering, and the part the *Journal* is playing in recording its growth.

H.G.C.

Engineering Institute of Canada, Annual Meeting, 1958

Chateau Frontenac, Quebec City, May 21, 22, 23

Fiftieth Anniversary of E.I.C. Membership

J. B. Challies, Hon. M.E.I.C.

Dr J. B. Challies, celebrates fifty years of membership in the Engineering Institute of Canada on December 12, 1957.

He has served the Institute well, as the *Journal* reported in 1950, when honorary membership was conferred upon him. The list of offices which he has held is extensive: secretary of the Ottawa branch, chairman of the Committee on Policy (1922), member of Council (1920-21), vice-president (1924), chairman of the Committee on International Co-operation, chairman of the Committee on Engineering Education and Degrees, chairman of the Ontario Provincial Division, treasurer (1935), member of the Consolidation Committee (1935-37), and president (1938).

Dr. Challies is the former director, vice-president and executive engineer of the Shawinigan Water and Power Company.

Engineering Alumni Medal Presented to

Dr. G. B. Langford

Dr. George B. Langford, head of the University of Toronto's department of geological sciences, was presented on November 2 with one of the highest awards a Canadian engineer can receive.

At the sixteenth reunion of the Engineering Alumni Association of the University of Toronto, J. R. White, president of the association and of Imperial Oil Co. Ltd., presented the Engineering Alumni Medal to Dr. Langford in recognition of his distinguished contribution to the profession. Only 12 others have been awarded since the inception of the honour in 1939.

More than 1,000 graduate engineers from the West Indies, the United States and Canada attended the two-day meeting. The association has a total membership of more than 10,000.

Dr. Langford was born in Ontario but received his early training in Calgary. He returned to study engineering at the University of Toronto and after graduation studied for his doctorate at Cornell University.

He has served as director of the Ontario Department of Planning and Development, as chairman of the North York Planning Board, and as a member of the Metropolitan Planning Board of Toronto.

His most recent contribution to the engineering profession is his chairmanship of the Committee for Registration of Engineering Technicians.

Dr. G. B. Langford (right) receives the Engineering Alumni Medal from J. R. White.

Survey of Scientific and Technical Manpower

The Federal Department of Labour is at present surveying professional men and women in scientific and technical fields. The purpose of the survey is to bring up to date the records of the National Register of the scientific and technical professions which has been maintained by the Department since 1942. Analysis of the Register records will supply a source of information on the characteristics of the supply of scientific and technical manpower, such as its age composition, its geographic location, the fields of specialization and functions within each field, education received, the incomes earned, and other characteristics.

A new questionnaire has been developed for the survey, one which can be completed with less effort than those used in the past.

The current survey is a part of a program in which one-third of the people in scientific and technical professions will be surveyed each year. Over a three-year period, everyone will have been covered. By this means, information on scientific and technical manpower in Canada will be maintained on a current basis. Those surveyed each year are selected on a random basis thus permitting the information secured to be used as a statistical sample representing the whole group.

There is a growing need for information on scientific and technical manpower in Canada. This survey provides the major source of information on professional manpower in the country. The Department of Labour's efforts, however, can only be of real value if the coverage of professionals in the country is extensive and the information on registrants is maintained on an up-to-date basis.

The Institute fully endorses the maintenance of the National Register of the scientific and technical professions and the survey being undertaken, and asks that all members who have received the questionnaire form this year cooperate fully in giving accurate information and mailing their completed forms to the Department of Labour as soon as possible.

Vocational Training for Women

Educators from all parts of Canada attending a meeting of the Canadian Vocational Training Advisory Council held in Ottawa in September, were urged to give greater consideration to vocational training for women.

Miss Marion Royce, director of the Women's Bureau of the Department of Labour, told the Council that at the present time 25 per cent of the Canadia labour force consists of women. She considers that such an important segment of the labour force should be encouraged to take advantage of vocational training opportunities to fit them for better and for a greater variety of occupations.

Miss Royce said that most girls anticipate some working experience as well as marriage. She pointed out that while there are no legal barriers to women in most vocational courses, there are many courses in which the participation of women is not encouraged as much as it might be. She also sees an urgent need for counselling and courses for mature women, designed to build confidence and skill.

In commenting on Miss Royce's address, Mrs. Rex Eaton, president of the National Council of Women, said that we must recognize the important part played by women in our economy. She suggested that a review of vocational training facilities for women might profitably be undertaken.

While these comments do not specifically mention the guidance of women into engineering, it might be expected that to some extent this would be one effect of intensified vocational training.

In other places, there is some concern for this matter, as the following excerpt from the September 6, 1957 issue of the *Electrical Review* indicates. (Published in London, England.)

"South Wales Switchgear, Ltd., which in conjunction with the Youth Employment Bureau has a scheme whereby grammar school students undertake one week's vacation training at the company's works at Blackwood, recently held an experimental course for fourth form grammar school girls, claimed to be the first of its kind in this country. The object of the course was to show the girls the possibilities of an engineering career. Thirty girls attended the course which proved to be a success. During the week they were shown the full range of a complex industry, extending from rate fixing and planning, material control, test, etc., in the factory, to the drawing office, design, research and sales departments. Lectures were also given by the company's executives on the various aspects and openings available in engineering".

OBITUARIES

The sympathy of the Institute is extended to the relatives of those whose passing is recorded here.

George Heckman Burgess, M.E.I.C., consulting engineer, member of the firm of Coverdale and Colpitts of New York, and of the American Institute of consulting engineers, died in New York City on March 1, 1957.

Mr. Burgess was born at Oshkosh, Wisconsin on June 19, 1874. He entered the University of Wisconsin in 1891 and four years later graduated with a Bachelor of Science degree in civil engineering. His earliest work was with the Edgemoor Bridge Works at Wilmington, Delaware; and the Pennsylvania Railroad Lines. He moved to Pittsburgh in 1896. With the latter company he was first employed in the bridge department. Later he was assistant engineer in charge of construction of shops, railroad stations and docks.

In 1905 he left the Pennsylvania to become associated with the Erie Railroad, and in 1906 became engineer of terminal improvements in charge of construction of terminals in the New York district and the monumental undertaking of the four track open cut and tunnel through Bergen Hill.

In 1909 his appointment as chief engineer of the Delaware and Hudson Company was announced. Mr. Burgess continued with that company until 1925, contributing to the solution of many of the problems involved with the valuation which was inaugurated in that year by the Interstate Commerce Commission. The experience he gained in this undertaking made him one of the leading authorities in railroad valuation.

In the summer of 1925 he joined the staff of the engineering firm of Coverdale and Colpitts. Three years later he was admitted as a partner to continue as such until the time of his death. His activities as a partner included not only participation in the firm's consulting work, but also various business activities. He was president of the Tennessee, Alabama and Georgia Railway Company from 1929 to 1945, and on his retirement remained as a director until the time of his death. He was president of the Burgess Battery Company from 1932 to 1936; a director of Shanferoke Coal and Supply Corporation from 1934 to 1939; a director of the Seaboard Air Line Railway Company from 1938 through 1946; director of Crocker-Wheeler Electric Manufacturing Company, 1939-1943; managing director and chairman of the board and executive committee of Petroleum Heat and Power Company, 1939 to 1942; director and member of the executive committee of Refined Syrups and Sugars, Inc., 1942 to 1948.

Mr. Burgess joined the Institute as a Member in 1912. He attained Life Membership in 1947.

W.O.I., J. N. Clemens, M.E.I.C., of Royal Canadian Air Force headquarters, Victoria Island, Ottawa, was killed in an air crash on July 3, 1957.

James Nicholas Clemens was born at Dauphin, Manitoba on July 6, 1912, and had his schooling there. He obtained a diploma in applied electricity in 1930 following an electrical engineering course with the International Correspondence School.

His early work was concerned with the installation of a water power plant at the God's Lake Gold Mines, and with the Hudson Bay Railroad.

From 1936 to 1941 he was assistant superintendent in charge of electrical distribution for the town of Dauphin, Man., and later worked as aerodrome foreman electrician in charge of power and lighting for No. 2 Training Command, Winnipeg, in the early days of World War II.

In 1944 he enlisted in the R.C.A.F. and served overseas.

Since that time he has been stationed with the North West Air Command, R.C.A.F. headquarters at Edmonton and the A.M.T.S./D.C.E.D., at headquarters, Ottawa.

Mr. Clemens joined the Institute as a Member in 1943.

NEWS OF THE

Associations and Corporation

Information received through co-operation of the provincial organizations.

BRITISH COLUMBIA

(This article was prepared by J. H. Bennett, P.Eng., assistant registrar of the Association of Professional Engineers of British Columbia for The B.C. Professional Engineer.)

The Engineer in Industry

Engineers in industry rate the high calibre of their colleagues, the opportunity for further training and the opportunity for advancement as the most satisfying factors in their present jobs.

These are some of the findings in the newly published survey report entitled "Career Satisfactions of Professional Engineers in Industry."

The publication is the latest in a series of executive research reports made under the sponsorship of the Professional Engineers Conference Board for Industry, in co-operation with the National Society of Professional Engineers.

Conducted by the Opinion Research Corporation, Princeton, New Jersey, the survey report is based on data gathered from interviews with several hundred professional engineers employed in industry in all the specialized technical fields. The lengthy "depth" interviews were designed to bring out the non-salary career satisfactions of engineers at three stages of professional experience—3 to 6 years, 10 to 15 years, and 20 to 25 years.

Sixty-seven per cent of the engineers in the 3-to-6-years-experience group stated that there were things lacking in the college training they received and approximately 76 per cent of those with more experience felt that there were deficiencies in their college training.

The survey also found that the most skepticism about the opportunities for advancement in engineering was expressed by men in the lowest technical jobs.

Six out of ten of the engineers surveyed reported that they have not held a full-time job with any company other than their present employer. Only one in five has experience with as many as two other employers.

The survey questions centered around such things as the engineer outside of his work, the career outlook of engineers, satisfaction and frustration on the job, the question of professional status, and the differences in values of the more successful engineers.

Eleven companies, each among the 200 largest corporations in the United States, were represented in the survey. The industries covered were: aircraft, automobile manufacturing, chemicals, electronics, electrical machinery, heavy equipment, petroleum refining, and rubber.

Engineers in the News

P. Klapp has taken a position with Timber Preservers Ltd., in New Westminster.

Bruce Walley is now employed by the B.C. Department of Highways as divisional engineer in charge of bridges on the Trans Canada Highway, in the Revelstoke area.

W. C. Palmer, P.Eng. is now with Canadian Fina Oil Limited. The address of this company is the Bamlett Building in Calgary.

E. C. Thomson recently accepted a position with H. A. Simons Ltd. He was formerly employed by Pacific Steel Erectors Ltd. at Kitimat.

C. D. Schultz, P.Eng. president of C. D. Schultz & Company, attended the seventh British Commonwealth Forestry Conference in Australia. This conference opened in Adelaide on August 26. Mr. Schultz was the official delegate of the Canadian Forestry Association.

A. Unsworth, P.Eng., who was formerly with H. A. Simons Ltd., has joined G. S. Eldrige Co. Ltd.

A. J. Bowering, P.Eng., plans to attend the conference of the Western Canadian Association of Highway Officials in Edmonton on October 7th, 8th and 9th.

W. R. McLauchlan, P.Eng., is now at Grand Forks, where he is employed by Northwest Telephone Company. He is responsible for the maintenance of microwave stations in that area.

J. T. Turner, P.Eng., is manager of the transportation Maintenance Sub-division of the B.C. Electric Company. In September, this sub-division received credit for an outstanding record in bus

H. D. Dawson, P.-Eng., and George Harford, P. Eng. (in parka) are shown chatting at the Municipal Engineers' Convention held at Victoria, B.C. in September. The event was reported in the November issue of the Journal.

maintenance when the Transportation Division of the B.C. Electric received the Fleet Owner Maintenance Efficiency Award at the annual meeting of the American Transit Association in Montreal. This is the second time only that a Canadian company has received this award.

D. F. Samis, P.Eng., formerly with Sidney Roofing, has accepted a position with the Pulp & Paper Division of McMillan & Bloedel Limited at Port Alberni.

G. Koster, P.Eng. is now plant manager for Fort Construction Company Limited.

G. P. Harford, P.Eng., municipal engineer of Prince George, was elected chairman of the Municipal Engineers' Division at the recent convention in Victoria.

S. H. deJong, P.Eng., associate professor of civil engineering at the University of British Columbia, has been appointed for a three-year term to the committee of the American Society for Engineering Education.

D. A. Wills, P.Eng., is now in Sydney, Australia, with a firm of civil engineering contractors.

W. P. Johnson has taken a position with the B.C. Power Commission.

Derek Franklyn, P.Eng., has joined the staff of Sealand Products Limited. He will act as consultant for the company which is the agent for micro-straining equipment.

R. D. Grantham, P.Eng., of Dominion Construction Company, has been transferred to Edmonton as manager of the company's Edmonton office.

Frank J. Berto, P.Eng., has left the Lago Oil & Transport Company in Aruba to take up post-graduate work at the California Institute of Technology.

MANITOBA

(Abstracted from the "Manitoba Professional Engineer," journal of the Association of Professional Engineers of the Province of Manitoba.)

P.Eng.'s Hold Civic Office

Three members of the Association of Professional Engineers of the Province of Manitoba were recently winners in civic elections held in the provincial capital.

Edward Kuiper, P.Eng., was elected to the School Board in St. Vital; **Robert A. Bird**, P.Eng., was re-elected to the School Board in Fort Garry, and **W. J. Ducharme**, P.Eng., who made his first bid for office this year was elected to Council in Fort Garry.

These elections are a personal tribute to the engineers who have already made a substantial contribution to their community affairs, and they are also an indication of the growing awareness on the part of the public of the need for able, qualified men in civic administration. These gentlemen are to be highly commended for their willingness to give of their time and effort to the administration of community affairs.

President N. S. Bubbis Reviews Summer Activities

While council continued to meet throughout the summer months, despite pre-occupation with the usual hectic program of summer work and the holiday period, the various committees also continued to work on their assignments. A special committee was set up to study the constitution of the Canadian Council of Professional Engineers which is being reviewed, President Bubbis reported.

A copy of a questionnaire on night school classes in engineering was circulated. The Junior Chamber of Commerce investigated this problem in Winnipeg, as a result of which it was found that a considerable number of people desiring post-matriculation education were interested in engineering. Council has also had numerous applications for registration from people who were not fully qualified. While the Act provides for written examinations and a uniform syllabus is available, it is obvious that it must be extremely difficult for most of the applicants to prepare themselves adequately on an individual basis. It is felt that night school courses in engineering might greatly assist in solving this problem, just as it has in other centres in North America and in Great Britain.

Council decided that as the professional engineering body in Manitoba it should interest itself in this problem and decided to co-sponsor the issuing of a questionnaire in order to survey the actual requirements of night courses in engineering. More than 300 people had shown themselves to be interested in evening courses by October. Sixty of these wished to follow post graduate studies. In addition to those mentioned there were a considerable number of requests from members of the Association for a night school course in Business Administration. It is the council's intention to assist in pursuing this matter further with the hope of seeing such courses established at the University.

ONTARIO

President Fox Says

(Abstracted from The Professional Engineer, the journal of the Association of Professional Engineers of the Province of Ontario.)

President Fox, in discussing 'Unity' said that it must not be forgotten that the provincial associations were fathered a generation ago by members of Canada's senior technical society, the Engineering Institute of Canada. At that time legislation or the lack of it seemed to cramp the full scope of the profession. Today we are faced with wider concepts and a need to move forward again.

Each of the major groups involved has definite, distinct duties and functions to perform and neither group should be expected to decrease or forego these functions and duties. A unified activity should enlarge the scope of each without duplication.

Problems on how to accomplish confederation are now under active review by committees of both groups, i.e. the Provincial Associations and the E.I.C. These committees met and made certain recommendations which were not acceptable to all Councils. The committees were then re-formed to make further recommendations after more complete study in the light of instructions from the Councils. Together they work as a Joint Committee of both groups. Mr. Fox is convinced that real progress is being made toward the development of a procedure for the ultimate enlargement and consolidation of activities—of not only the provincial Associations and the E.I.C., but of the other technical societies in Canada and branches of international engineering groups also.

President Fox said that 'Unity' is a project large in scope and of tremendous challenge. It is hoped that local and self interests will not prejudice nor hinder decisions that can and must be made so that plans for unity can be formulated and finalized. These are not local problems, they are not confined to the present generation, therefore experience does not enter the picture. Mr. Fox adds that decisions made now will influence the whole of the engineering profession in Canada for many decades to come.

Ontario today has 16,094 registered professional engineers in Ontario, an increase of 1,317 over 1956, it has been announced by the Association of Professional Engineers of Ontario.

Association Council Adopts Technician Program Revision

The Council approved revision of the engineering technician program which would classify the first three grades as engineering technicians, and the top two grades as engineering technologists (grades I and II). Originally all five grades were classified as engineering technicians.

Council was advised that 419 applications for certification as engineering technicians and technologists have been received, with 247 already having been processed. The provinces of Manitoba, Alberta and British Columbia have expressed interest in the program and are considering instituting similar certification legislation.

A two-part group retirement savings plan for members has also been presented for consideration. It would be available to all members under the age of 70. The plan is in two parts, an insured annuity retirement savings plan and a trust investment retirement savings plan.

Council also approved a motion to establish a committee on accreditation of university courses pertaining to engineering. It was felt that while existing techniques of the U.S. Engineering Council for Professional Development may be most helpful, the development of a Canadian technique is desirable. Chairman of the accreditation committee is Professor R. G. Lord, P.Eng, of the University of Toronto.

Engineers in the News

Stanley C. Jones, P.Eng., has been appointed engineer on the staff of the director, Naval Program Control, as assistant director Naval Program Control (Construction), in the Department of National Defence, Ottawa, Ont.

C. F. Moore, P.Eng., of Canadian Industries Ltd., has moved from Shawinigan Falls, Que. to Edmonton, Alta., where he is acting resident engineer of the C.I.L.'s plant expansion in that city.

M. S. Juzyez, P.Eng., has joined Avro Aircraft Ltd., Malton, Ontario, as electronics engineer in the electronics system department.

Graduating in engineering from Munich in 1949, Mr. Juzycz obtained his M.A.Sc. degree in electrical engineering at the University of Toronto in 1952. He is presently a graduate student in the Institute of Business Administration, University of Toronto.

Prior to joining Avro Aircraft he was on the staff of the Department of Electrical Engineering of Toronto University, with the Canadian Westinghouse Co. Ltd. and latterly has been development engineer with Decca Radar (Canada) Ltd., Toronto.

Burt A. Avery, P.Eng., who formerly held the position of chief design engineer at Orenda Engines Ltd., Malton, has been appointed deputy chief engineer responsible for the design, aerodynamics and material department of the company.

Gordon D. Paseoe, P.Eng., has joined Babock-Wilcox & Goldie-McCulloch Ltd., Galt, Ont., as a project engineer. He was formerly with the Canadian Locomotives Co. Ltd., in Kingston, Ont.

W. H. Davis, P.Eng., has accepted the appointment of lecturer in engineering science at the University of Western Ontario, London, Ont.

Dr. Alex Muraszew, P.Eng., formerly chief experimental engineer at Orenda Engines Ltd., has been named deputy Chief engineer responsible for the development department, experimental shop and the company's test establishment at Nobel, Ont.

Keith G. Lightwood, P.Eng., has moved from Toronto to Seattle, Wash., where he has accepted employment with the Boeing Airplane Company's transport division at Renton, Wash. Mr. Lightwood, who graduated from the University of Toronto in 1949, has enrolled in the Graduate School of the University of Washington in a course leading to a Master's degree in aeronautical engineering.

Peter W. Brown, P.Eng., who graduated from the University of Saskatchewan in 1954, has resigned from Bailey Meter Co. Ltd., Toronto, to take up duties in the office of the Engineer-in-Chief, Naval Technical Services, Department of National Defence, Ottawa, Ont.

Roy L. Hurd, P.Eng., is general manager of South African Motor Assemblers and Distributors Ltd., Uitenhage, South Africa.

A graduate from Queen's University, Kingston, in 1948 with honours in civil engineering, Mr. Hurd joined the Ford Motor Company of Canada Ltd., in Windsor. His first assignment was in connection with foremen and supervisory training in the manufacturing and assembly plants in Windsor. Later he moved to the Overseas Division and held the post of general organization planning manager. During the years 1952 to 1955 he travelled overseas to Ford plants in India, Malaya, Australia and New Zealand. In 1955 he transferred to Ford Motor Company of South Africa in the capacity of executive assistant to the managing director.

During summer of this year he accepted the general managership of South African Motor Assemblers and Distributors. This company has assembled Studebaker cars, Austins and Volkswagens. Currently the company is engaged in the assembly and distribution of Studebakers and Volkswagens for the markets of South and South West Africa.

H. J. Fineh, P.Eng., of the Hydro-Electric Power Commission of Ontario is now living in Port Arthur, Ont., where he is personnel officer, Northwestern region of Ontario Hydro. He was formerly personnel officer in the engineering division in Toronto.

Dr. Anton F. Mohrnheim, P.Eng., has moved to Kingston, Rhode Island, and has accepted the appointment of associate research professor in metallurgy at the University of Rhode Island.

W. B. Drowley, P.Eng., formerly with Republic Floro Meters Canada Ltd., Toronto, has accepted a position with the Ontario Department of Health, Air Pollution Control, Toronto.

Douglas C. Alexander, P.Eng., is project engineering supervisor, Analytical and Control Division, of the Consolidated Electrodynamics Corp., of 300 N. Sierra Madre Villa, Pasadena, Cal.

H. N. Hutchison, P.Eng., of Defence Construction (1951) Ltd., is now located in Port Arthur, Ont. He was formerly associated with the Camp Gagetown project in New Brunswick.

Alan D. Seharf, P.Eng., has left the electrical apparatus sales division of Ainsworth Electric Co. Ltd., Toronto, and has accepted the position of staff electrical engineer with the Potash Company of America Ltd., Saskatoon, Sask.

Walter G. Ward, P.Eng., has been appointed general manager of the apparatus department of Canadian General Electric Co. Ltd. In his new capacity Mr. Ward succeeds J. Herbert Smith, P.Eng., who recently was elected president of the company.

Mr. Ward heads a department which employs 4600 people in the plants at Peterboro, where he will be located, in Guelph and in sales offices of the company across Canada.

A graduate of McGill, Mr. Ward joined Canadian General Electric in 1945, following service in the R.C.N., as a lieutenant-commander (radar and communications). His first responsibilities with the company were those of manager of the electronic equipment section. In 1952 he was made manager of the major appliance operation in Montreal and two years later general manager of the appliance department. Following an assignment on organizational work with the General Electric Company he was appointed manager of induction motors in Peterborough in 1956 and earlier this year was named general manager of the entire sales department.

Lloyd M. Priee, P.Eng., manager of engineering of Radio Valve Co. Ltd., Toronto, has recently retired.

Mr. Price has been active in both the Institute of Radio Engineers and the Radio Electronics Television Manufacturers Association. He is a Fellow of I.R.E., has been active in committee work and has served as chairman of the Toronto section of I.R.E. In R.E.T.M.A., in addition to his committee activity, he served as chairman of the Component Section for two years and as vice-president of the Association.

Earl W. Gagan, P.Eng., has resigned from his position as chief engineer at Lake Asbestos of Quebec, Ltd., to take up residence in Toronto and to enter private consultation as a mining engineer. His office is located in Suite 309, 200 Bay Street, Toronto.

David F. Witherspoon, assistant professor in the Department of Agriculture at the Ontario Agricultural College, Guelph, Ont., has been granted a leave-of-absence for one year to study hydrology and reclamation in the Netherlands. His course of study is part of the International Course in hydraulic engineering which is sponsored by the Netherlands Universities Foundation for International Co-operation. He will be located at the Delft Technical University, Delft, Netherlands.

Personals

News of the Personal Activities of Members of the Institute

Ralph C. Pybus, M.E.I.C., of Vancouver was eleeted president of the Canadian Chamber of Commerce at the annual meeting in September.

Mr. Pybus is president and general manager of Commonwealth Construction Company. He is a former chairman of the Vancouver Branch of the Engineering Institute of Canada.

J. W. McCammon, M.E.I.C., (B.Se., McGill, 1912) has been appointed a member of the United Nations Technical Assistance Team to advise the governments of Thailand, Cambodia, Laos, and South Viet Nam on the proper proeedures to be adopted for initiating a scheme of development of the Mekong River within their territorial limits in respect to power, distribution, irrigation and navigaton.

Mr. MeCammon left Monteal about November 19 and will be absent for a period of three months.

On July 15, 1957, Mr. MeCammon retired from the position of eommissioner and general manager of the Quebee Hydro Electrie Power Commission at Montreal.

Claude P. Beaubien, M.E.I.C., (B.Se., business and engineering administration, M.I.T., 1934), is president of the Montreal Board of Trade.

Mr. Beaubien is manager of sales, at Montreal with The Aluminum Company of Canada.

T. M. Patterson, M.E.I.C., (B.A.Sc., eivil, Toronto, 1925) is direetor of the Water Resources Braneh of the Canadian Department of Northern Affairs and National Resources, Ottawa. This Braneh replaces the former Water Resources Division. The three senior offieers, all of them members of the Institute, are Mr. Patterson, **J. D. McLeod,** (B.A.Se., eivil, U.B.C., 1939) ehief engineer, and **R. H. Clark,** (M.Eng., eivil, McGill, 1945) chief hydraulie engineer.

E. L. Neal, M.E.I.C., (B.Se., meehanieal, Queen's University, 1938) has been eleeted to the Board of Directors of Gaspesia Sulphite Co. Ltd., Chandler, Que.

General manager of the eompany, Mr. Neal has also been appointed a vice-president.

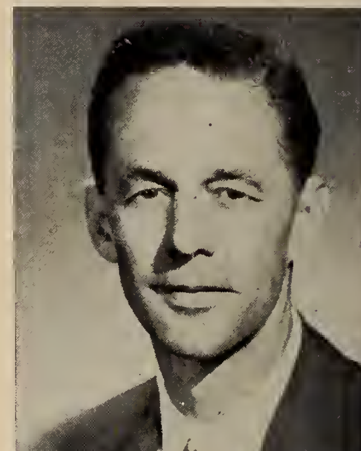
C. G. R. Armstong, M.E.I.C., (B.A.Se., Toronto, 1920), a Windsor, Ont., consulting engineer was reeently awarded two honours at a eonvention of the Canadian Institute on Sewage and Sanitation held in Toronto. Mr. Armstrong was presented with the past-president's certifieate for his leadership in 1955-56. He is one of four members honoured this year with certifieates for 20 years continuous serviee to the C.I.S.S.

John Gilchrist, M.E.I.C., (B.Sc., electrieal, New Brunswiek, 1932) whose appointment has been announeed by the Stavely Coal & Iron Company Limited, London, England, as president of Standard-Modern Tool Company Limited, is also ehairman of the boards of The A. R. Williams Maehinery Company Limited, A. R. Williams Machinery Western Limited and Pacifie Traetor & Equipment Limited.

Mr. Gilchrist is the former managing director of Ex-Cell-O Corporation of Canada Limited.

T. M. Patterson, M.E.I.C.

M. Eaton, M.E.I.C.



W. O. Horwood, M.E.I.C.

W. O. Horwood, M.E.I.C., (B.Eng., meehanical, MeGill 1937) is the vice-president, sales, for the Napanee division of International Equipment Co. Ltd., Montreal. He is the former Eastern sales manager of the industrial division of I.E.C.

P. B. Macfarlane, M.E.I.C., (Royal Teehnical College, Glasgow, 1936), of the Atlas Asbestos Company Limited, Montreal, has received the appointment of general sales manager with the firm. Mr. Macfarlane was previously manager of the sales engineering department of the company at Montreal.

Leo Scharry, M.E.I.C., (B.A.Sc., civil, Eeole Polytechnique, 1946), of Montreal has been appointed viee-president of the Leduc Electrical Company in that city. Mr. Seharry was formerly teehnieal sales representative of the Sangamo Company Limited, and the Wagner Electric Comeompany, both of Montreal.

Milton Eaton, M.E.I.C., (B.S., electrical, MeGill, 1921) ehief engineer of Shawinigan Chemieals Limited, Shawinigan Falls, Que., has retired after thirty-five years serviee, and now eonduets a business as a consulting eleetrieal engineer in Shawinigan Falls.

Mr. Eaton has been particularly interested in the development of eleetrie boilers and is responsible for the development of automatie eontrols and other improvements for high voltage electric boilers.

He is a past-ehairman of the St. Mauriee Valley Braneh of the Institute.

Photo courtesy Canadian National Railways.

E. A. Ford, M.E.I.C., (B.Sc., civil, Manitoba, 1927) assistant to the vice-president and managing director of Dominion Bridge Company Limited, Lachine, Que., has been named vice-president, marketing, following a recent announcement.

R. J. A. Fricker, M.E.I.C., (B.Eng., mining, McGill, 1940) has been promoted to vice-president, manufacturing, following a recent announcement from Dominion Bridge Company Limited, Montreal. He previously held the post of assistant to the vice-president and managing director.

M. McMurray, M.E.I.C., (B.A.Sc., metallurgy, Toronto, 1939) was recently promoted to vice-president, finance and administration, with Dominion Bridge Company, Limited, Montreal. He was formerly assistant to the vice-president and managing director of the firm.

P. E. Savage, M.E.I.C., (M. Eng., civil, McGill, 1934) assistant to the vice-president and managing director of the Dominion Bridge Company Limited, Lachine, Que., has been appointed vice-president engineering with the organization.

Ross A. Ritchie, M.E.I.C., (B. Eng., mech, McGill U., 1943), of the Electric Reduction Company of Canada Limited, has received an appointment with the firm as vice-president manufacturing. Recently Mr. Ritchie has carried out the duties of assistant chief engineer with the organization at Toronto.

J. W. Demcoe, M.E.I.C., (B.Sc., civil, Manitoba, 1939) is general superintendent, of the Maritime district, of Canadian National Railways, with office at Moncton, N.B., transferring from North Bay, Ont., where he was general superintendent. He has served with C.N.R. in Toronto and Montreal and other centres.

E. A. Ford, M.E.I.C.

M. McMurray, M.E.I.C.

E. S. Buhayer, M.E.I.C., (B.Sc., engineering, University College, London, 1938) is working in Chester, Pennsylvania, in the mechanical research Department of Scott Paper Company.

He was formerly in Montreal in the design office of C. D. Howe Co. Ltd.

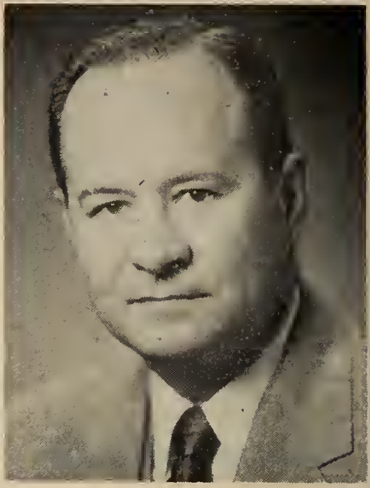
E. S. English, M.E.I.C., (B.Sc., civil, Manitoba, 1932) is assistant chief engineer for the Western region, of Canadian National Railways, with office at Winnipeg, Man. He had earlier been with the C.N.R. system in Montreal, Winnipeg and Regina.

W. K. Sproule, M.E.I.C., (M.Sc., metallurgy McGill, 1937) has transferred to the International Nickel Company, Inc., in New York. He has been at Copper Cliff, Ont., as superintendent of research for International Nickel Company of Canada Ltd.

C. L. Moon, M.E.I.C., (B.A.Sc., mechanical, Toronto, 1934) has been appointed chief engineer of the Fruehauf Trailer Company of Canada Limited.

Mr. Moon was formerly associated with Avro Aircraft Limited.

R. J. A. Fricker, M.E.I.C.



P. E. Savage, M.E.I.C.

C. E. Craig, M.E.I.C., (B.Sc., mechanical, Queens, 1938) is at Shawinigan Falls, Que., works manager in the Shawinigan fabricating works, of Aluminum Co. of Canada Ltd. Joining the Company soon after graduation, he has recently been in the sales division in Montreal.

John Penzer, M.E.I.C., is manager of the electrical manufacturing division of Canadian Comstock Co. Ltd., St. Catharines, Ont. He was formerly associated with Taylor Electric Manufacturing Co. Ltd., London, Ont.

H. W. Hignett, M.E.I.C., (B.Sc., civil, Manitoba, 1936) is executive director of the Central Mortgage and Housing Corporation, at Ottawa. He is the former supervisor of the Ontario Region of C.M.H.C., in which capacity he was located in Toronto.

A. Sandilands, M.E.I.C., (B.Sc., electrical, Manitoba, 1934) has been appointed by Phillips Electrical Company Limited, Brockville, as assistant general sales manager (western). He will be located in Edmonton.

Mr. Sandilands has been associated with the company in the West for 16 years.

S. C. Cooper, M.E.I.C., (B.A.Sc., civil, University of Toronto, 1945) is the vice-president and general manager of C. A. Pitts General Contractor, Ltd., Toronto, and associated firms.

Mr. Cooper has been with the company since 1945, having been appointed chief engineer in 1948.

W. B. Jackson, M.E.I.C., (B.Sc., civil, Alberta, 1945) is the general superintendent for Canadian National Railways, in the Northern Ontario District, at North Bay, Ont.

• PERSONALS

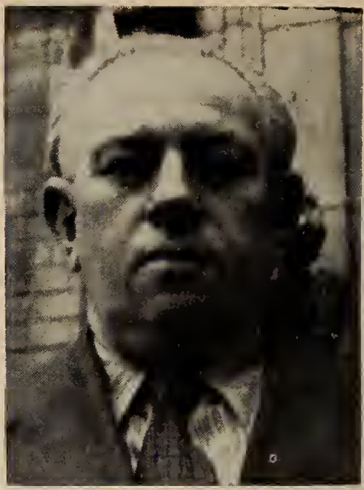
Mr. Jackson joined the C.N.R. system soon after graduation, and has since served in positions at Montreal, Levis, Cochrane, London and Toronto.

C. R. Matthews, M.E.I.C., (B.Eng., mechanical, McGill, 1943) has been since August 1957 located in St. Jerome, Que., with Dominion Rubber Co. Ltd. Earlier he worked with E. B. Eddy Co., at Hull, Que.

E. de Haas, M.E.I.C., (M.A.Sc., engineering physics, University of Delft, 1946) is working at the Palmer Laboratory, Princeton University, as senior electrical engineer. He had been working on special projects of Ontario Hydroelectric Power Commission, in Toronto.

A. S. Vadas, M.E.I.C., (civil, Budapest, 1922) has been for some time the owner of the Inter-Cosmos Trading Company, working in export, import, distributing, with headquarters in Montreal.
Associated companies, established in Canada and the U.S.A., are Zanzibar Trading Company, and Globus Advertising Agency.

Eric Heaton, M.E.I.C., (B.Eng., civil and structural, National University, Ireland, 1947) joined Warnock Hersey Company in March, 1957, as a project engineer to carry out an investigation into load bearing capacity of the highway system in Nova Scotia. He was earlier employed by Montreal Engineering Company, and by the St. Lawrence Seaway Authority, in Montreal.


A. S. Vadas, M.E.I.C.

A. S. Dromlewicz, M.E.I.C., (is a resident) engineer for the United Waterways Constructors Ltd., Montreal, on the upper Beauharnois lock of the St. Lawrence Seaway. He is, however, a member of the engineering staff of Foundation Company of Canada, Limited.

G. W. Spratt, M.E.I.C., (B.Eng. 1953, M.Eng., 1956, McGill) has been appointed operations manager of Macdonald and Macdonald Limited, inspection and testing engineers, Vanvouver.

Robert E. Walker, M.E.I.C., (B.Sc., mechanical, Queen's, 1952) is in charge of a new sales and service office in Montreal for Vickers-Sperry of Canada Limited.

Ewart M. Haacke, M.E.I.C., (B.Sc., electrical, Queens, 1942) has been appointed the sales manager of the lighting division of J. A. Wilson Lighting and Display, Ltd.


E. M. Haacke, M.E.I.C.

PERSONALS

Mr. Haacke was formerly eastern district manager, having joined the company in 1951 as Montreal Branch manager.

R. W. Walker, M.E.I.C., formerly of Montreal, J. T. Donald & Co. (1956) Ltd., is with Associated Engineering Services Ltd., Edmonton, as chief industrial engineer.

Lt.-Col. M. Turner, R.C.E., M.E.I.C., (R.M.C., 1939, B.Sc., Queen's, 1947) advises his present position is area engineer, British Columbia Area, and Commanding officer of 11 Works Company, Royal Canadian Engineers, at Vancouver, B.C., headquarters.

William C. McLean, M.E.I.C., is a project engineer for Catalytic Construction of Canada Ltd., at Sarnia, Ont. Earlier he was in Valleyfield, Que, a project engineer with Canadian Arsenals, Ltd.

Thornton E. Smith, M.E.I.C., (B.S. civil, Massachusetts Institute of Technology, 1948), treasurer of the New York building firm of Kuhn, Smith and Harris, Inc., has been elected president of the organization.

Prior to joining Kuhn, Smith and Harris, Inc., in 1955 Mr. Smith was associated with the firm of Fraser, Brace and Company and with the Industrial Engineering Company, both of New York.

T. E. Smith, M.E.I.C.

A. Swystun, M.E.I.C., (B.Sc., mechanical, Saskatchewan, 1946) is an office engineer for the firm Dutton-Williams-Mannix Ltd., in engineering and inspection for construction of the Alberta Gas Trunk Line natural gas pipe line system.

A. F. Tiesdell, M.E.I.C., is employed as lecturer-in-charge of the mechanical engineering department of the Eastern Ontario Institute of Technology, Ottawa. He was earlier with the Sarnia Northern Collegiate Institute and Vocational School.

W. B. Drowley, M.E.I.C., (B.A.Sc., mechanical, Toronto, 1945) is with the Ontario Government, Air Pollution Control, Department of Health.

He was formerly associated with Republic Flow Meters Canada Ltd., Toronto.

W. C. Phillips, M.E.I.C., (B.Eng., civil, Saskatchewan, 1951) is the chief engineer of United Grain Growers Ltd., in Winnipeg, Man.

Mr. Phillips was earlier located in Regina, in the employ of the Saskatchewan Wheat Pool.

Walter G. Lunick, M.E.I.C., (B.Sc., mechanical, Manitoba, 1952) is teaching engineering science, mathematics and materials and processes of industry, at Danforth Technical High School Toronto.

He has been an industrial engineer with Julius Kayser & Co. Ltd., in London, Ont.

F. E. Hertha, JR.E.I.C., has recently changed his address from Montreal to Prince Rupert, B.C. where he holds the appointment of financial analyst with the Columbia Cellulose Company.

Previously associated with the Canadian Chemical and Cellulose Company

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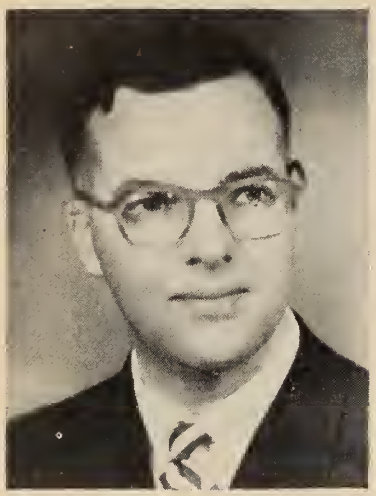
in the Eastern city he also had his early professional experience with the Hollingworth and Whitney Paper Company in Waterville, Maine.

E. G. F. Sweet, JR.E.I.C., (B.A.Sc., mechanical, Toronto, 1948) has been appointed chief engineer of the Brantford coach and Body Ltd, Brantford, Ont. Mr. Sweet joined the firm in 1951 and since that time has been instrumental in development of new designs and improvements.



E. G. F. Sweet, JR.E.I.C.

H. R. M. Murray, JR.E.I.C., a Glasgow University graduate, class of 1946 has been transferred from Vancouver to Yale, B.C. with the firm of A. B. Sanderson and Company Ltd., to be resident engineer on the new Alexandra Bridge. The bridge is part of the Trans Canada Highway and will include an 805 ft. fixed arch span over the Fraser. River.

C. H. Johnson, JR.E.I.C., with Canadian General Electric in various capacities since 1949 has moved from Toronto to join Du Pont Company of Canada Ltd. at Montreal. He is employed as a design engineer on new developments.

He studied mechanical engineering at the University of Manitoba.

C. T. Armstrong, JR.E.I.C., who graduated from the University of Toronto in 1952 in civil engineering has resigned his position with the Corporation of the City of North Bay, Ont., and has joined the Department of Planning and Development, housing branch, at Toronto.

C. M. Cotton, JR.E.I.C., has recently been elected secretary-treasurer of the Lakehead Branch of the Institute.

Mr. Cotton is a 1950 graduate of the University of Manitoba with a B.S. degree in electrical engineering. He is an electrical engineer with the Canadian Car and Foundry Company, automotive division at Fort William, Ont.

G. P. Milton, JR.E.I.C., is the new secretary-treasurer of the Northern New Brunswick Branch of the Institute. A design engineer with the Bathurst Power and Paper Company Limited, at Bathurst, N.B., he is a graduate of the Nova Scotia Technical College, class of 1949.

W. E. Donahoe, JR.E.I.C., (B.Sc., civil, U.N.B., 1948) an engineer with Intrusion-Prepakt Limited, has been transferred from Toronto to Fredericton, N.B.

B. F. Davies, JR.E.I.C., (B.A.I., civil, 1954) is an engineering trainee in the B.C. Marketing Division of Imperial Oil Ltd., Vancouver. He was formerly in the design section of the Hydro Electric Power Commission of Ontario.

Richard Levi, JR.E.I.C., (B.Eng., mechanical, McGill, 1955) is with Richmond Pulp & Paper Co. Ltd., Bromptonville, Que.

Ross G. Aishford, JR.E.I.C., (B.A.Sc., chemical, Toronto, 1954) has been working in Moncton, N.B. since the summer this year, as an industrial sales engineer and commercial sales represent-

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HEAD OFFICE BELLEVILLE, ONTARIO — BRANCH OFFICES: MONTREAL, TORONTO, VANCOUVER ative for Taylor Instrument Companies of Canada for the Atlantic Provinces. He has been with the company for three years, working in Toronto, and in Montreal.

W. J. Romanowicz, Jr.E.I.C., (B.Eng., metallurgical, N.S.T.C., 1951) is now employed as a scientific officer, in the Mines Branch of the Department of Mines and Technical Surveys, Ottawa. He was formerly with the Ontario Research Foundation in Toronto.

Hugh M. Steeves, Jr.E.I.C., B.Sc., mechanical, Queen's, 1951) has been transferred from Spruce Falls Power & Paper Co. engineering staff to Kimberley Clark Products at Niagara Falls.

H. B. Fudge, Jr.E.I.C., (B.A.Sc., civil, Queen's, 1954) has been appointed construction and maintenance engineer for Alberta, in the marketing department, British American Oil Co Ltd., Calgary.

E. H. McIntyre, Jr.E.I.C., (B.Eng., metallurgical, McGill, 1953) has resigned from his position of laboratory supervisor with Sorel Industries Ltd., and has joined Canadian Steel Wheel Ltd.

Frank J. Berto, Jr.E.I.C., (B.A.Sc., mechanical, U.B.C., 1952) has resigned from his position of project engineer for the Lago Oil and Transport Co Ltd. to take post graduate work at the California Institute of Technology.

H. N. Atkins, Jr.E.I.C., (B.A.Sc., civil, Toronto, 1954) is an engineer in the Sudbury branch of the Bell Telephone Co. of Canada Ltd. Mr. Atkins formerly served the company in the special contract department at Bird, Manitoba.

J. E. Kryzanowski, S.E.I.C., a 1957 graduate of the University of Toronto in civil engineering is employed in the design engineering department of the Dominion Bridge Company Limited at Toronto.

R. E. Barry Moffatt, S.E.I.C., who graduated from the University of New Brunswick this year with a B.Sc. degree in civil engineering has joined the Dibblee Construction Company Limited, engineering staff at Ottawa.

W. C. Ramsden, S.E.I.C., (B. Eng., civil, McGill, 1957), is assistant resident engineer on the Manitou Falls project for the Hydro-Electric Power Commission of Ontario.

C. C. Vallance, S.E.I.C., (B.Eng., civil, Saskatchewan, 1957) is employed by the government of Saskatchewan in the Highways Department as project engineer. He was earlier with the design branch of the City of Regina engineering department.

R. D. Pousette, S.E.I.C., (B.A.Sc., mechanical, Univ. of B.C., 1957), who joined the Shell Oil Co. of Canada Ltd. right after graduation, is employed at their Shellburn Refinery as design engineer.

G. T. Dewburst, S.E.I.C., (B.Eng. mechanical, Saskatchewan, 1957) is presently employed as an application engineer with Honeywell Controls Ltd., in Calgary.

Kenneth E. Tingley, S.E.I.C., (B.Eng., electrical, N.S.T.C., 1957) is with the Canadian General Electric Company Ltd in Peterborough, as a student engineer on the Test Course.

Ian H. Mitchell, S.E.I.C., (B.Eng., mechanical, McGill, 1957) is employed by Avro Aircraft Limited of Malton, Ont., as a design engineer in the equipment design department.

D. A. Elliott, S.E.I.C., (B.A.Sc., engineering and business, Toronto, 1957 is employed as field and design engineer by Dravo of Canada Limited, Toronto, Ont.

Paul E. Beaulieu, S.E.I.C., is appointed regional specialist, in the power apparatus division of the Northern Electric Company Ltd., Quebec, Que.

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NEWS OF THE BRANCHES

Activities of the Forty-Seven Branches of the Institute and abstracts of the papers presented at their meetings

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Lively Summer Program

Under the energetic leadership of W. H. Ackhurst — chairman of the Branch— the summer program was one of the liveliest and most enjoyable of the recent years.

The June meeting took form of a garden stag party at the residence of H. R. Sills, vice-president of E.I.C. In a genuine "Bier Garten" atmosphere a record number of members enjoyed an evening with sauerkraut, brass-band, songs and superb fellowship.

First annual E.I.C. Golf Day for Peterborough and District was held on 10 August at the Kawartha Golf and Country Club. All E.I.C. members in Peterborough, Belleville and Port Hope districts were invited to compete for the "R. L. Dobbin Trophy" donated by R. L. Dobbin, M.E.I.C. and past president of E.I.C. The invitation was also extended to all nonmember professional engineers in the districts. The Golf Day was a success, both regarding the participation and the weather. With almost thirty per cent of the players non-E.I.C.'ers the winner of the "R. L. Dobbin Trophy" for low net was a Branch member, V. A. Taylor, JR.E.I.C. (*see picture page* 1870)

The organizer of the Tournament itself was W. C. Durant, JR.E.I.C.

D. B. A. Chase, secretary-treasurer of the Branch and H. R. Sills, vice-president of the E.I.C., second and third from the left, view the construction of the Iroquois dam and locks during the St. Lawrence Seaway tour, September 14.

Tour of St. Lawrence Seaway and Power Project.

On September 14 a tour was organiz-

Members of the Peterborough Branch of the Institute at the Barnhart Island Power house site which was visited during the tour of the Seaway on September 14. Members were able to inspect the famous project before it is completed.

• BRANCH NEWS

ed to give the Branch members a good opportunity to see the famous project before it is completed. The members showed great interest for the tour especially as several of them are engaged in designing electrical equipment for the project.

The trip was made on a special train to Cornwall and back from Brockville to Peterborough. The distance between Cornwall and Brockville was covered by bus and all the major project areas were visited — including Barnhart Island powerhouse, Long Sault control dam, new town sites and finally Iroquois control dam. A dinner meeting was held in Manitonna Hotel in Brockville before leaving for Peterborough.

It was a pleasure to note the great interest of the Branch student members in the trip, indicated also in a good participation. Peterborough Branch is very fortunate in having a very active student membership with the total number close to thirty. The student members have been very valuable in helping the executvies to organize a great deal of the Branch activities. (*See picture page 1872*).

CAPE BRETON

W. L. Dodson, Jr.E.I.C.,
Secretary

Presidential Visit

Marking the official visit of President C. M. Anson to his home Branch (Cape Breton), on Saturday, September 28, a special dinner meeting and dance was held at Isle Royal Hotel, Sydney. In the President's party were past president Dr. Ira P. McNabb and regional vice-president H. W. L. Doane, both of Halifax and Dr. L. Austin Wright, general secretary of the E.I.C.

Special dinner meeting guests included C. N. Murray, president of the Dominion Council for Professional Engineers, Dr. Arseneau, local chairman of the C.I.C. and Hon. N. Manson, Minister of Mines and Resources for the Province of Nova Scotia.

To a receptive gathering of 130 members, their ladies and guests, the president spoke of the responsibility of the Engineer in Management.

Presentation

In- recognition of the honour Mr. Anson has attracted to the Cape Breton Branch through his election to the presidency of the E.I.C., the local branch presented Mr. Anson with a suitably engraved, hand-carved gavel of local maple and steel from the first ingots made in the new open Hearth of Dominion Iron and Steel Limited, of which Mr. Anson is vice-president and general manager.

Attaining Life Membership, W. S. Wilson was presented with the gold pin of the E.I.C. by president Anson.

After the dinner meeting, all enjoyed

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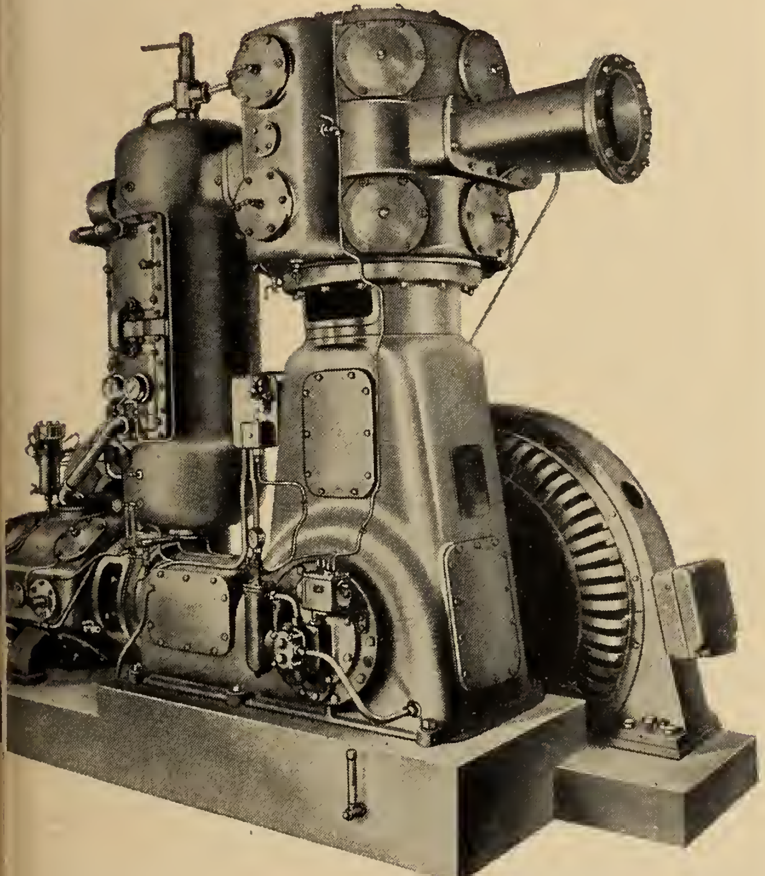

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• BRANCH NEWS

the dancing and music of the President's Ball.

Executive Meetings

Two fully attended executive meetings were held with the president, on Friday and Saturday, Sptember 27, 28. Both meetings were lively and it would seem that the ideas behind Confederation of the E.I.C. and the professional association are uppermost in the minds of a majority of the local executive.

Following the meeting on Friday, Mr. Anson and the Branch Chairman, W. A. MacDonald, paid a visit to the home of Major C. M. Smythe, an invalid confined to his home, to bestow honours on him in attaining Life Membership in the E.I.C.

KINGSTON

D. I. Ourom, Jr.E.I.C.
Secretary-Treasurer

Radioisotopes Discussed

Industrial application of radioisotopes was the subject of a talk given by M. T. Neill, of Isotope Products Limited, Oakville, Ont., to the Branch on October 22.

It was explained that radioisotopes are finding wide acceptance in industrial processes and offer many interesting and profitable possibilities for future developments.

The use of isotopes in mass measurement techniques, in continuous process industries such as the paper, rubber and plastics is now highly developed. There are many installations where radiation instrumentation is automatically controlling processes and producing improved product quality and increased efficiencies.

Techniques involving the use of beta and gamma radiation were also discussed.

Buildings for Chemical Plants

R. N. Boyd, of the Du Pont Company of Canada (1956) Ltd., on November 12 discussed "Buildings for Chemical Plants" before the Kingston Branch. He said, "The effective housing of various types of chemical operations poses many interesting problems. This paper deals with some of the factors requiring consideration, such as corrosion resistance, weather tightness, special interior finish requirements, appearance and cost. The paper is illustrated with a number of examples of the constructions used by the author's Company for its diversified operations."

LAKEHEAD

C. M. Cotton, Jr.E.I.C.
Secretary-Treasurer

George A. Walker, Jr.E.I.C.,
Publicity Chairman

Management Consultant Talk

The Lakehead Branch of the Engineering Institute of Canada has had two

Peterborough: F. R. Pope (centre) is shown presenting the Ross L. Dobbin Golf Trophy to V. Taylor who won it for low net. W. Durant, looking on, was chairman of the E.I.C. golf tournament held in Peterborough for the Peterborough and surrounding areas. Mr. Dobbin, due to illness was unable to present the trophy himself.

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SPECIALISTS IN FABRICATED PIPING—CARBON AND ALLOY STEEL recent meetings of interest.

At the September meeting R. E. Henderson, vice-president, manufacturing, of Canadian Car Company Ltd. spoke on the use of management consultants in industry.

Management consultants can do enormous good, but only if company managements understand their uses and limitations, according to Mr. Henderson. Management consultants are offering an increasingly important service which deserve to be more widely understood he said. More and more firms are using outside consultants to assist in the improvement of basic organizational arrangements, accounting procedures, management of inventories and many similar problems.

To show why consultants are called in by thriving companies, what they do,

Peterborough: Student Members of the Branch who took part in the tour of the St. Lawrence Seaway held on September 14. Left to right are: B. Ahern; E. G. Bazeley; D. J. Kawaja; C. L. Pelton; S. Taylor; J. G. Pearsall; A. Canzi; J. Simpson and F. E. Lucas.

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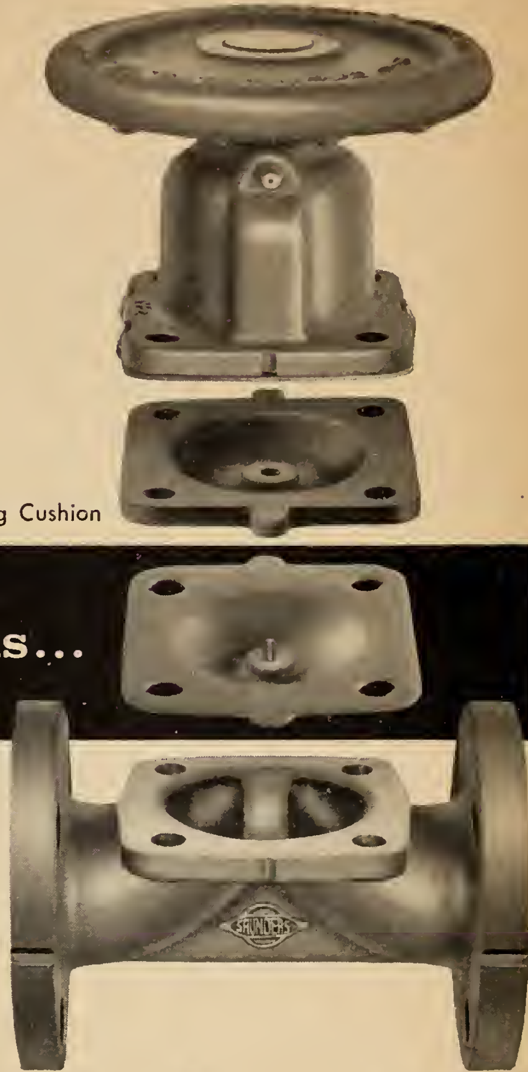

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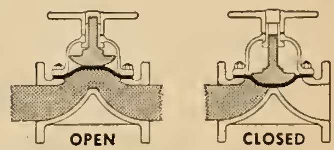
Diaphragm life depends on temperature, pressure and frequency of operation. Inquiries must include complete service data to receive prompt and careful attention.

Service Conditions	Saunders Valve Now Used	Service Life: Teflon Diaphragm	Service Life: Previous Valve
Case 1. Benzene hexochloride (30%-40% benzene, free chlorine); 120 to 130 F, 10 to 20 psi; operated 3 to 4 times daily	Glass lined bodies; Teflon Diaphragm; 1 to 3 inches	10 to 14 mos.	1 to 2 mos.
Case 2. 90%-95% HNO_3 plus 1.8% HF (specific gravity 1.62—1.77) 115 F in summer; 40 F in winter; 125 psi; operated 2 to 3 times daily	Durimet 20 body; Teflon Diaphragm; 1 to 3 inches	8 months	2 months
Case 3. $AlCl_{+2}$ complex; ambient to 220 F; 0-50 psi; operated 1 to 2 times daily	Glass lined bodies; Teflon Diaphragms; 1 to 4 inches	9 months	6 months
Case 4. Sulphuric acid 85%; outside temperature; no pressure; operated 4 times daily	Iron bodies; Teflon Diaphragms, 2½ inches	Still in service after 1 year	3 weeks



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- Resilient diaphragm assures positive, leak-tight closure even with grit or scale in the line.
- Diaphragm absolutely isolates working parts from fluid . . . sticking, clogging, contamination, corrosion eliminated.
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pipe fittings • welding fittings • pipe hangers • valves • Grinnell-Saunders diaphragm valves • pipe prefabricated piping • heating specialties • water works supplies • Grinnell automatic fire protection systems what their reports recommend and how recommendations should be carried out, Mr. Henderson traced the story of a typical problem from its inception to its solution and showed the contribution to company planning made by outside specialists. He also reviewed what thinking was essential prior to deciding upon consultants and determining their terms of reference.

The October meeting was held at the new Lakehead College of Arts and Science in Port Arthur. Following a short address by H. Braun, principal of the College, the members were conducted through the premises and viewed the facilities with great interest. Mr. Braun touched on the highlights leading to the final establishment of the Lakehead College and outlined the current curriculum as well as plans for the extension of the courses.

Book Presented

E. Charnock, on behalf of the Lakehead Branch of the E.I.C. presented a book to Mr. Braun for inclusion in the College library. This book has created considerable interest in engineering circles both in Canada and the U.S.A. The title of the book is "Daylight Through the Mountain" based on the life and letters of Walter and Francis Shanly, two early Canadian engineers.

The meeting was chaired by Mr. V. B. Cook and the speaker was introduced by D. MacKinnon and thanked by J. Rymes.

LETHBRIDGE

R. D. Hall, Jr.E.I.C.
Secretary-Treasurer

P.F.R.A. Tour

On Saturday, September 7 over 60 members, guests and their wives toured the P.F.R.A. Belly River diversion project, then continued to Waterton Lakes National Park for a golf tournament, dinner, and dance.

The Belly River diversion, part of the St. Mary's and Milk River development under construction at an estimated cost of $2,500.00 will divert water from the Belly River to the St. Marys River for irrigation purposes. It consists of a diversion weir on the Belly River, a few miles from Waterton. From the wire, a main canal, 27 miles in length extends to the St. Marys River reservoir. This canal has a capacity of 2400 sec. ft.

The party assembled at the St. Marys damsite, then toured the main canal to the camp site at the diversion weir. Enroute a stop was made to study construction features of one of the drop structures. At the camp site, an excellent lunch was provided by the P.F.R.A. Immediately after lunch the party was taken to the diversion weir and headgate structure, where the details and general layout was explained by the hosts. W. L. Foss, M.E.I.C., supervising construction engineer, St. Marys and Milk River development, P.F.R.A., Lethbridge was in charge of the tour. R. B. Wells, M. Hunka, and Dave Cramer of the P.F.R.A. assisted Mr. Foss.

The tour completed, the group motored to Waterton Park for afternoon and evening social activities. Highlight of the afternoon was the low score golf tournament held on the park's scenic 18 hole golf course. Low gross and low net score honours for the tourney went to Tom Henry, M.E.I.C. of Calgary.

Prize for the most honest golfer was awarded to Ted Lawrence, M.E.I.C. Al Kenwood, M.E.I.C. was in charge of the golf tournament.

The day's events culminated with refreshments and dinner in Kootenai Lodge, under the chairmanship of the Branch chairman, J. R. Milne.

Arrangements for the tour were made by W. B. Thomson, M.E.I.C., Branch vice-chairman, and program chairman. Out of town guests, included Tom (Ace) Henry and Redge Bailey of Edmonton, formerly of Waterton Lakes.

LONDON

G. W. Chorley, M.E.I.C.
Secretary Treasurer

George Hayman, JR.E.I.C.
Publicity Chairman

Presidential Visit

The annual visit of the president took place on October 24 when the London Branch welcomed president Anson. Mr. Anson was accompanied by Dr. Garnet Page, recently appointed assistant general secretary to the E.I.C.

Members of the London Branch executive joined Mr. Anson at a luncheon


DRAVO

given by the engineering faculty of the University of Western Ontario at the University. Immediate past-president of the Institute, V. A. McKillop, London, Ont., and two former executive members J. Vance from Woodstock and S. V. Buchanan of London, Ont., were included. Mr. Anson addressed the engineering undergraduate students during the afternoon.

At a cocktail party held at the residence of V. A. McKillop many of the industrial leaders of London had the opportunity to chat with Anson.

A dinner was also held for engineers and their wives. More than ninety persons attended.

In some measure the success of the evening is attributed to the newly formed Engineers' Wives Association. An informal coffee party was held at the home of Mrs. McKillop in September which was attended by 75 women. It was the first local meeting of the organization.

NIPISSING AND UPPER OTTAWA

R. A. Booy, JR.E.I.C.,
Secretary Treasurer

J. W. Millar, M.E.I.C.,
Branch News Editor

DuPont Official Speaks

The monthly dinner meeting of the Branch, chaired by Jim Chandler was held Wednesday, November 13.

The guest speaker, H. Lloyd Johnston was introduced by Don Briden, works engineer of the North Bay plant of Du Pont of Canada.

Mr. Johnston, whose headquarters are in Montreal is chief engineer for Du Pont of Canada. He is a graduate of McGill University and joined Canadian Industries Limited in 1936, serving as plant engineer and works manager. In 1954 he was transferred to his present position with Du Pont.

Evaluating Performance

Evaluating performance in an engineering department was the subject of Mr. Johnston's address. He said that different departments have different functions and numbers of staff. About 40% of companies have a formal system for rating employees. Opinion differs as to the need and benefit of such plans and as to the type of plan which will produce the desired results.

Rating plans are used for sorting performance, making selections for promotion, establishing salary differential, and determining training needs. The various plans are classified as graphic, chart, check list, self-rating, field review, etc.

Mr. Johnston favoured a rating plan that combined a concise paragraph, with rank, order, and position, experience and performance rating. He demonstrated with illustrations the way in which such a plan functioned in his own department. He pointed out that the period between ratings might vary but ratings should be taken often enough, probably once a year, so that new employees unsuited for the work they were doing could be culled or transferred to other departments where they might make better progress. Different departments frequently compared ratings of employees with a view to making such transfers.

Post-Appraisal Interviews

Post-appraisal interviews were desirable particularly where an employee's rating was low. It was advisable to talk to an employee about his performance pointing out where his weaknesses were, but a discussion of his traits should be avoided. However, there should be no attempt to mould a person into a standard character.

Following an interesting question period Herb Watson thanked the speaker for a most informative address.

OTTAWA

W. V. Morris, M.E.I.C.,
Secretary

C.C.A. Head Speaks

T. N. Carter, of Toronto, president of the Canadian Construction Association, in his address to the Ottawa Branch on October 3, 1957, describing briefly some of the basic characteristics of the construction program and the operations of the industry and then touched on some related subjects such as the training of construction engineers and the relationships between members of our two national organizations.

Mr. Carter said that the association of

contractors and engineers is the oldest formalized association on record, dating to Roman times. Calling for closer co-operation between the two he felt that it would result in better service to mutual clients.

The growth of the construction industry in recent years has paralleled some of the new industries whose percentage increases are spectacular because they scarcely existed a decade or two ago.

Volume $6.9 Billion

This year it is estimated that Canada's construction volume will amount to $6.9 billion. In 1946 the volume was $1.6 billion. Over $3 billion or roughly 46% is classified as engineering construction and the plans bear the stamp of professional engineers. Engineers, working in association with architects are responsible for the structural, mechanical and electrical designs for the $2 billion of non-residential buildings being erected and also for the multiple unit buildings in the housing field. They are designing roughly $4 billion of construction work this year. Engineers' work in construction design is making a greater contribution to the development of Canada than in any other field. He added that if Canadian engineers and architects can design boldly it is in large measure due to the fact that no matter what they ask for they know that the Canadian construction industry can deliver it.

Construction Risks

Mr. Carter said that construction engineers do not usually have a set fee for services and especially in the heavy construction field large sums of money must be invested in equipment, and in the event of a design failure, a contractor may be sued by the owner and compensation paid for from the sale of his assets. Design engineers have some say over the calibre of their competition since only qualified engineers may belong to the provincial organization. Competition in the construction field is wide only from home and abroad, and is subject to great risk.

Joint Problems

Dealing with some of the joint problems of contractors and designers he said that most of the problems that arise are due to the vast and increasing volumes of work being carried out under great pressure. Canada is a country in a hurry and it is inevitable that we suffer some growing pains in the process. Steady progress is being made towards the solution of mutual problems by joint meetings between representatives of the design professions and the construction industry at the national, provincial and local levels.

Suggestions

From the contractors standpoint, consulting engineers can help to remove uncertainties from work and reduce costs to the owners by:

1) Providing more detailed information and by the quicker processing of their accounts. This included pre-engineering, greater clarity in drawings and specifications and faster action on decisions, change of orders, progress and final payment. One example: some of the "standard" plans coming from Ottawa have so many addenda that they exceed the original specifications in thickness. The mark of a good set of plans and specifications is frequently a set of bids which are very close to each other and to the estimate, since clarity and completeness of tendering information facilitates accurate estimating. Designers with a bad reputation for delays will have an allowance for this added cost factor including in the tender amounts submitted for their projects.

2) By supporting in thought, word and deed the tendering and contract procedures agreed to and approved by the professions and the industry. The Standard Forms of Construction Tender and Contract are long-established documents revised from time to time in accordance with new conditions. Back in 1951 an E.I.C., R.A.I.C., C.C.A. joint committee issued nine "Points of Agreement" in the tendering practice field and last year "A Suggested Guide to Bidding Procedure" was published.

3) By assuming a greater responsibility for their work. This may be a question of convincing the owner's legal departments that they should have more confidence in their design engineers and architects, Mr. Carter felt. If responsibility for the accuracy of sub-surface conditions, completeness of design, etc., are assumed by the designer, the contractor can omit an allowance to cover potential expenses which in most cases is not required. Changes can be negotiated as they occur and the owner of course stands to benefit.

Mr. Tullis closed his remarks with a Hamlet-like soliloquy on whether the strains and stresses, risks and returns of the contracting business are worth the struggle.

SASKATCHEWAN

R. Bing-Wo., M.E.I.C.
Secretary-Treasurer

First Winter Dinner Meet

A group of thirty-one members gathered in a private dining room at the Hunt Club on Monday, October 21, 1957, to enjoy the first of the proposed monthly winter dinner meetings to be held in Regina.

The chairman of the dinner meeting, R. J. Genereux, urged the members to take part in the weekly evening meetings of the Professional Development Course which is already underway each Monday night.

Those present at the dinner meeting were privileged to hear a talk by G. H. Nielsen of the Canadian Petroleum As-

sociation in Regina, who was introduced by R. M. Harry. Mr. Nielsen's address, entitled, 'The Magic Barrel' described the many and varied products used in our everyday living which are produced by the petrochemical industry from petroleum and natural gas. The talk was highlighted by numerous demonstration and exhibits.

K. W. Allcock, who thanked the speaker for his interesting and entertaining presentation, reflected the appreciation of those present.

ST. MAURICE VALLEY

J. O. Hachey, Jr.E.I.C.,
Secretary

E. A. Love, Jr.E.I.C.,
Publicity Committee Chairman

Varied Program

The Branch executive has planned a series of meetings for the winter months which are calculated to cover the interest of all members of the Branch. As dates remain uncertain, it is not yet possible to publish a list of the meetings. These will take place at Trois-Rivieres, Shawinigan Falls, and Grand 'Mere. Field trips out of the Valley have been proposed.

First meeting of the Branch for the fall term was held October 8, at Trois-Rivieres. J. E. Lalond of the Bank of Montreal, business development department, addressed the Branch on the subject of "Inflation." The question and answer period which followed indicated the active interest of those gathered.

SUDBURY

W. J. Ripley, Jr., M.E.I.C.,
Secretary Treasurer

Algom-Nordic Trip

The first meeting of the 1957-58 season took the form of a field trip to the Nordic plant of Algom Uranium Mines Ltd. on October 19. Thirty nine members and guests from the Sudbury branch met a group of twenty from Saulte Ste. Marie at the junction of the Elliott Lake road and Highway 17, whence the combined party proceeded to Algom-Nordic for lunch at the commissary. W. J. Ripley senior, vice-president of the Institute for Ontario, delivered a brief address, in which he stressed the need to strive for greater recognition for engineers' professional standards, and the necessity for engineers in every phase of activity. Mr. Ripley was introduced by Messrs. Harvey Snell and Jim Smith, chairman of the Sault Ste. Marie and Sudbury branches respectively.

Surface Plant-Mill Visited

The party was later escorted through the mine surface plant and mill by members of the staff of Algom Nordic. After inspecting the compressor house, boilers, hoist room and crushing plant, the visitors enjoyed a most interesting tour through the grinding plant and the mill, and were able to gain an insight into the processes by which the uranium in the ore is dissolved in acid, separated from the valueless rock, concentrated by ion exchange, and precipitated as the yellow oxide.

After the tour, thirty four of the Sudbury branch members proceeded to the Espanola Hotel for an excellent dinner.

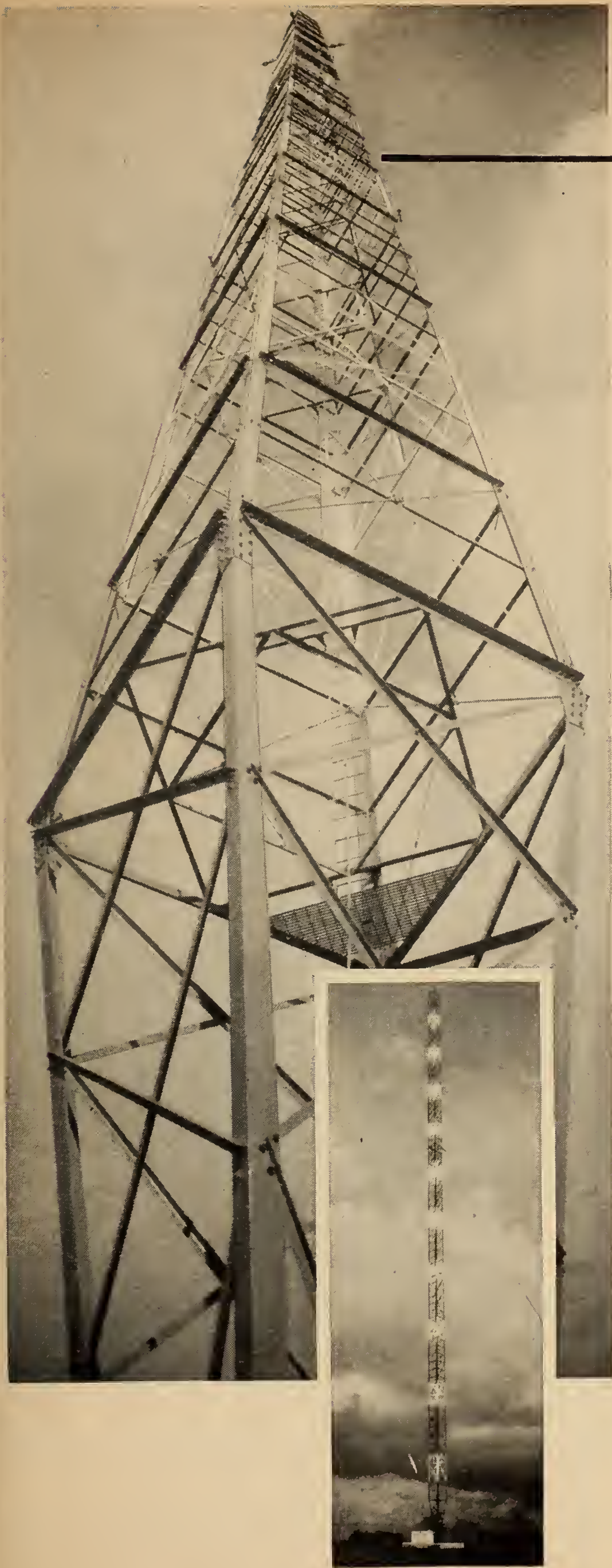
TORONTO

D. S. Moyer, M.E.I.C.,
Secretary Treasurer

A. C. Davidson, M.E.I.C.,
Branch News Editor

Engineering and the I.G.Y.

On October 29, Dr. John Tuzo Wilson of the Department of Geophysics of the University of Toronto, gave an evening talk to some 127 members of the Toronto Branch on "Engineering and International Aspects of the I.G.Y." Dr. Wilson has had much to do with I.G.Y., a successful joint venture of many of the na-



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tions of the world. He was the local chairman of the meeting held at the University of Toronto by the International Union of Geodesists and Geophysicists (I.U.G.G.) which was held recently in Toronto.

Dr. Wilson traced the history of the various sciences which are connected with or in some way allied to geophysics. These are geography, geometry, geology, and geodesy. It was about 98 years ago that Darwin gave impetus to the beginnings of modern scientific thought with his theory of evolution, and Agassiz made it clear that the supposed evidence of the biblical flood was in reality the history of the earth commuted to stone. Geophysics itself is concerned with the interior of the earth, its crust, what is going on in the oceans, and occurrences in the upper atmosphere.

It is remarkable how much is known about the remoter parts of the earth, and how little is known about the more populous sections, particularly those about the equatorial zone.

Some of the branches of geophysics, such as seismology, vulcanology and geology, have revealed the nature of the earth's interior with considerable exactitude, although no one has ever been there.

Over the past century geophysics developed from informal groups to IUGG. This formal union decides how to study the various subjects making up geophysics, what standards to set, and how to report the information gathered.

The predecessors of IGY were the Polar Years of 1882 and 1883, and the years 1932 and 1933. The present IGY will cost about $1 billion and is certainly getting ample publicity for things geophysical. Phenomena which fluctuate rapidly are being studied this time to get a better correlation. An inventory of glaciers is being taken. Why? Well, consider the change in river flow which would occur if all the glaciers melted. The level of all the world's oceans would rise, affecting the coast lines of the continents. Dams would have to be built on any remaining rivers so that irrigation of the interior plains could be economically done, and the displaced populations of the seaboards accommodated and fed.

Aside from the political implications, Dr. Wilson emphasized that the launching of the Russian satellite was a major scientific achievement. The launching was expected in scientific circles, and had even received some publicity in the popular press about six months ago. Free discussion in scientific circles overrides political frontiers. A wonderful opportunity is available to scientists and engineers to increase and preserve peace in the world through these various international bodies.

The speaker was introduced by Harvey Self and the thanks of the meeting were tendered by Sid Segsworth, who made the point that science is an important vehicle to carry information between politically unco-operative groups.

Joint Committee Meeting

About 50 heard Major-General H. A. Young address a meeting of the Joint Toronto Area Committee of the EIC-ICE-ASCE on "The Development of New and the Extension of Existing Dock, Harbour, and Port Facilities". The meeting was held on the University campus on October 31.

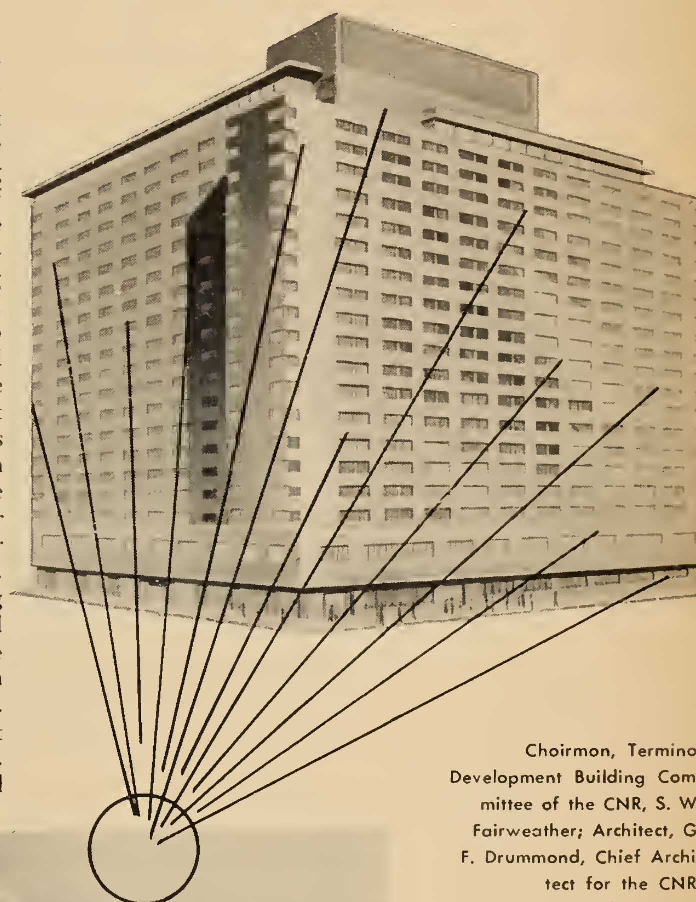
Maj.-Gen. Young based his remarks on the effect that the St. Lawrence Seaway is expected to have on the trade of the Great Lakes area. The volume of shipping to

he new QUEEN ELIZABETH HOTEL
f dollars annually

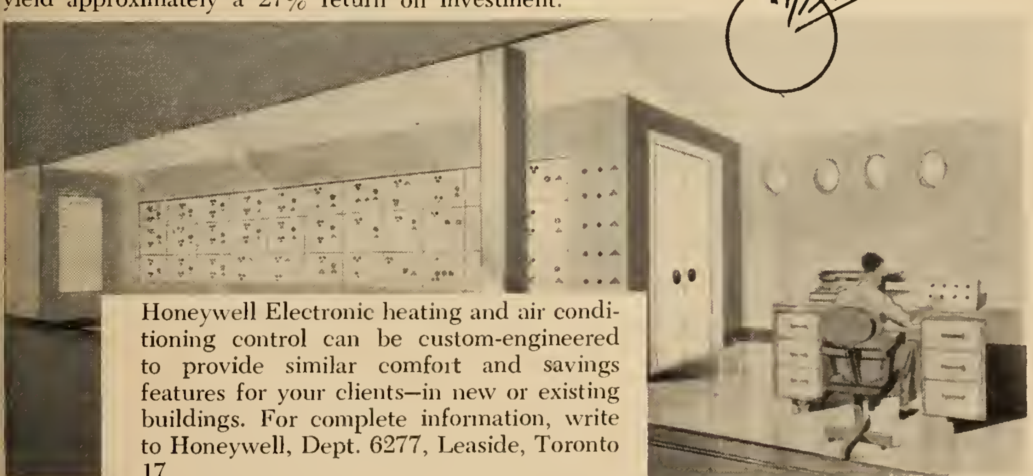
HONEYWELL ELECTRONICS IN THE NEW QUEEN ELIZABETH HOTEL WILL ENABLE ONE MAN TO CONTROL OR CHECK 200 OPERATING POINTS IN 7 EQUIPMENT ROOMS

Rising to a height of 21 stories, the new 1200-room Queen Elizabeth Hotel will dominate the site of the CNR's magnificent Terminal Development Program in Montreal. When completed early in 1958, the Queen Elizabeth will be **the first hotel in the world** with a centralized electronic heating and air conditioning control system.

Nerve centre of the system is an electronic master control panel (below) from which one man will control or check 200 operating points in 7 equipment rooms at various levels throughout the hotel. Patterned after the giant control centres in modern chemical and refining plants, this Honeywell system applies the principles of automation to human comfort and efficiency. Unique feature of the system is an electronic scanner that continuously checks temperatures throughout the building and automatically logs the information for the engineer. **Maintains perfect year round indoor climate.** Superb comfort. That's the end result of this ingenious centralized electronic heating and air conditioning system. In the hotel business, this means guest satisfaction . . . and it translates into dollars and cents. With temperatures uniformly correct throughout the hotel—with ventilation and humidity always at the right level for comfort—the Queen Elizabeth can rightly expect to build a regular clientele. Comfortable temperatures will be assured for meetings, banquets, dinners, dances and other activities. **Saves thousands of dollars in maintenance and operating costs.** With centralized control of the entire heating and air conditioning system in the hands of one man, the Honeywell electronic system in the new Queen Elizabeth Hotel will save more than $12,000—in manpower alone. Thousands more in fuel and power savings will result from the improved overall efficiency of the system. Total operating savings, after carrying charges, will yield approximately a 27% return on investment.



Chairman, Terminal Development Building Committee of the CNR, S. W. Fairweather; Architect, G. F. Drummond, Chief Architect for the CNR; Mechanical and Electrical Engineer, N. S. B. Watson, CNR; General Contractor, Pigott Construction Company, Ltd.; Mechanical Contractors, John Colford Contracting, Ltd. and Canadian Comstock Company, Ltd.



Honeywell Electronic heating and air conditioning control can be custom-engineered to provide similar comfort and savings features for your clients—in new or existing buildings. For complete information, write to Honeywell, Dept. 6277, Leaside, Toronto 17.

HONEYWELL

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*Tradename

be expected is limited by the locks, the channel depth, and the number of ships which can pass through a lock at a given place. The volume of traffic will likely rise from the present amount of 10 million tons to about 35 million tons in the near future. Most of the increase will be just lake traffic, carrying bulk cargo of ore, wheat and coal. As an indication of what the future may hold in the way of foreign trade, the estimated foreign tonnage is about 3 per cent of the total tonnage entering Toronto harbour at the present time.

Next followed an outline of the responsibilities of the Department of Public Works and overall, the Dominion Government, in the opening and maintenance of any harbour, coastal or inland, any new dock facility or the maintenance of it.

How the design of a channel is made formed the next topic, using Toronto Harbour as an example. To add one foot extra depth would cost $4 million, so the choice of depth must be done with great care.

The thanks of the group was tendered to General Young by Mr. Sefton.

Capacitator Development

On October 22 the Joint Committee of the Toronto Branch, E.I.C., and the Institution of Electrical Engineers assembled at the University of Toronto to hear P. A. Sporing, general manager of the Telegraph Condenser Company in England and a director of Telegraph Condenser Company (Canada) deliver an address on Capacitator Development in Great Britain.

Dr. L. G. Brazier, director of research for British Insulated Callender's Cables Limited is the co-author of the paper and had hoped to present it jointly with Mr. Sporing. Unfortunately Dr. Brazier's visit to Canada has been postponed due to unforseen circumstances. The paper included an account of the new low pressure polythenes, and wide variety of capacitator manufacturing techniques such as vacuum metallisation and dielectric film on metal.

VANCOUVER

A. D. Cronk, JR.E.I.C.,
Secretary

J. J. Kaller, M.E.I.C.,
Publicity Chairman

Structural Section Meets

M. V. Conventry, project engineer of Swan, Wooster and Partners, Vancouver, consulting engineers, addressed the Structural Section recently on "Basis and Criteria for the Design of the Second Narrows Bridge." His talk was followed by a lecture on structural details and methods of construction of the bridge piers and prestress concrete approaches on the north end of the bridge given by C. Stanwick, resident engineer, also of the firm of Swan, Wooster and Partners.

Geophysics Talk

Dr. John A. Jacobs and Dr. R. W. Stewart, professors of the University of British Columbia presented a joint lecture on Geophysics to the Vancouver Branch on October 23.

In giving the history of the international Union of Geodesy and Geophysics, Dr. Jacobs explained the necessity of large international meetings and exchange of information, due to the global extent of geophysics ranging from geodesy, seismology and meteorology, through geomagnetism and scientific hydrology to physical oceanography, vulcanology and earth and atmospheric chemistry.

Unless simultaneous observations are made, the piecing together of geophysic research material is of relative value to the science of geophysics, therefore the greatest possible number of surveys, observations and research at the same time in order to obtain a comprehensive picture of geophysical phenomena occurring simultaneously throughout our globe.

● BRANCH NEWS

Such intensification of geophysical research takes place every three years and each such year is known as the Geophysical Year.

To systematize world geophysical research, observations this year will be concentrated on the two poles, along the equator and three meridians. These studies will cover observations of the sun, from which result most of this planet's atmospheric disturbances—ionospheric physics, oceanography, glaciology, seismology and gravity among many others.

Dr. Stewart's Remarks

Dr. Stewart devoted his part of the address largely to meteorology and oceanography. He stressed the fact that there is a great need for improving long range weather forecasting and for this reason every tenth day of the geogphysical year is devoted to the measurement of every possible meteorological phenomena. It is now known that the polar air is very cold and extremely turbulent. Small centres of the cold masses of air become detached and result in storms. The practical implications of these observations are obvious.

Study of the southern and northern or water and land hemispheres, will be made with regard to the influence of one hemisphere upon the other.

Many investigations constitute only research material for the future scientists. For example, the amount of carbon dioxide on this planet is estimated to be on a steady increase. This may result in a warming up process with a consequent effect on global glaciation. The amount of increase of CO_2 is expected to be measurable not sooner than 25 years from the present. Future researchers may find however that CO_2 merely changes its location.

Distribution of ocean currents will receive more extensive study. It is now known that, for example, the Gulf Stream has its counterpart in a current of the same order which flows along the ocean floor in an opposite direction.

Research on the age of the water in the depth of the ocean will provide the answer to the question as to whether the oceanic depths may be suitable for the dumping of atomic wastes.

Scientists are puzzled by the fact that there is an apparent shifting of water between the southern and northern hemisphere and that the variations amount to approximately 6 meters. Dr. Stewart said that the scope of interests is growing to such an extent that one day the present International Union of Geodesy and Geophysics might become an Institution of World Scientists.

VANCOUVER ISLAND

J. A. Cowlin, Jr.E.I.C.
Secretary-Treasurer

Georgia Generating Station

J. P. Sinclair, project engineer, presented a paper October 16 on the Georgia Generating Station which is just coming into production. With four 25,000-hp. units, this turbine generating station will supply a standby load to supplement the hydro-electric generating stations on Vancouver Island. Within two years after the construction of this plant was authorized, at least two of the units will be in production.

Seventy members of the Vancouver Island branch took advantage of a field trip on October 19 through the Georgia Generation Station through the generosity of the B.C. Power Commission, for whom the plant was constructed. With perfect fall weather, the visitors had ample time to examine the deep-sea dock, the tank farm and the switching station as well as the generating station, itself.

News of Other Societies

C.G.R.A. Meets at Saskatoon

Saskatoon was selected as the meeting place for the annual convention of the Canadian Good Roads Association held on September 25-28, 1957. Delegates were welcomed by the Hon W. J. Patterson, lieutenant governor, Hon. J. T. Douglas, Saskatchewan minister of highways and His Worship John McAskill, mayor of the city. The Hon. Hugh John Flemming, premier and minister of public works, Province of New Brunswick, was elected president of the association for 1957-58.

President's Annual Review

CGRA President P. A. Gaglardi told delegates Canada's economic and social activities had grown from the parish to the province and tomorrow would be encompassed only by the boundaries of the nation. The life of the Association had spanned most of the evolution of the automobile during the past half century. To what purpose it will function in the next half century would depend upon continuation of the co-operation we enjoy among our members. Its effectiveness would depend upon the soundness of plans made for the future."

Roads Roundup

The afternoon session of the first day was devoted to reports on progress and problems of road building across the country from coast to coast.

British Columbia reported the largest highway construction program in its history. Last year over 15 million cubic yards of rock and earth had been moved, more than double the previous year. This year since April another 11 million yards had been moved. Trans Canada mileage would be a little less than the 81 miles done last year, due to heavier construction and some four-lane construction. Total paving this year would be 250 miles of plant mix and 150 miles of base processing. The day-labour program was also very extensive.

Out of the 565 miles of Trans Canada through B.C., some 460 miles were completed or under construction, leaving 100 miles to be completed. Four major bridges, as well as tunnels, were included in the Trans Canada work along the Fraser river. In the lower mainland there were some 77 miles of multiple-lane highway. On the southern trans-provincial highway 485 miles of the total of 559 miles were completed or are under construction.

The new Second-Narrows bridge will be completed early in 1959. The new Kelowna bridge over Okanagan Lake would be completed in a year's time. The Nelson Bridge would be completed in October. The Deas Island four lane tunnel under the Fraser River, 8,100 feet long, was well under way.

Alberta reported appropriations for 1957 at a new high with total proposed expenditure of $63.4 million, a major portion of which would be on main highway and bridges. Total highway vote this year was some $38 million, with $7.56 million to be applied to the Trans Canada Highway. Six million dollars had been allotted for bridges and $2.8 millions to maintenance.

The 1957-58 grading program would involve 304 miles, stabilized base course 263 miles, asphaltic plant mix surfacing 312 miles. The bridge program included 19 major bridges of which five were on the Trans Canada. Of special interest was the new suspension bridge over the Peace River at Dunvegan, 2,375 feet in length and costing $4.5 million, with a 900 foot centre span.

The Trans Canada was completed from the Saskatchewan border to Calgary. Of the remaining 67 miles to Banff Park, only 2¾ miles were not under construction. The remaining 34 miles of grading would be completed this year, together with the 57 miles of base course.

Weather conditions had been most advantageous for highway construction, and the Highways Department looks forward to completion of its 1957 program before freeze-up. Winter maintenance was becoming less and less of a problem with each new highway.

Saskatchewan reported its 1957 highway budget up substantially from 1956 at $22.5 million, excluding assistance to municipalities. Trans Canada work was down somewhat from previous years due to completion of this project. Weather had been favourable, sufficient equipment was available and prices were slightly lower than for 1956. Materials were in good supply and no labour shortages had developed.

With completion of Saskatchewan's share of the Trans Canada, an official opening had been held in August. Completion of the provincial highway between Estevan and Weyburn was expected by freeze-up and further oil surfacing near North Battleford. Comfortable driving will be possible from North Portal through Regina and Saskatoon to Lloydminster. Paving was completed from Saskatoon to Prince Albert. Oil surfacing and paving were finished from Swift Current to Saskatoon, and paving will be finished from Regina to Yorkton this season.

Only one major bridge had been started this year, at Nipawin, though a crossing of the Beaver river near Meadow Lake might be started later.

Manitoba reported the province was again in line with all other provinces in carrying out an expanded highway program this year. Due to an early spring more grading and paving than usual had been done in April and May.

Manitoba's share of the Trans Canada Highway was completed from the Ontario boundary through Winnipeg to Portage la Prairie. From there to west of Brandon will be completed in 1958. Between Brandon and the Saskatchewan border it has been completed for years.

Canadian Good Roads Assn. Officers

President: Hon. H. J. Flemming, Premier and Minister of Public Works, N.B.

Vice-President: Hon. J. T. Douglas, Minister of Highways and Transportation, Sask.; Hon. J. N. Allan: Minister of Highways, N.S.; Hon. R. D. Robertson, Minister of Public Works, Man.; Hon. J. G. MacKay, Minister of Highways, P.E.I.

Immediate Past President: Hon. P. A. Gaglardi, Minister of Highways, B.C.

Hon. Secretarys T. J. Mahony, Managing Director, O.G.R.A.

Hon. Treasurer: Major-General R. H. Keefler, C.B.E., D.S.O., vice-president, The Bell Telephone Company of Canada, Montreal.

Managing Director: C. W. Gilchrist, O.B.E.
Assistant Managing Director: R. A. Draper.

• OTHER SOCIETIES

The portion west and south of Winnipeg, the metropolitan perimeter route, would be completed within the time of the agreement.

Municipalities, towns and cities throughout the province had all expanded their road and street improvement programs, with assistance varying between 50 to 65 per cent of construction cost on approved market roads and highway routes through cities and larger towns. A start had been made on a mining development road in northern Manitoba to serve the nickel development and the hydro development on the Nelson River.

Ontario reported that for the third successive year its Highways Department was operating on a record high budget. A total of over $234 million would be spent this year compared with $203,800,000 in 1956-57. Of this total, $121.7 million was allocated to new construction on King's highways and secondary highways; $50.4 million to maintenance and administration, and $60 million mainly to subsidies on municipal roads and streets.

Weather conditions and other factors had been most favourable for construction and work had proceeded more rapidly than anticipated. It may be necessary to defer calling further contracts on some projects and include them in next year's program. Action had been taken to expand training courses for graduate engineers and technicians, now in short supply. The second year of a five year highway research program in co-operation with Queen's and Toronto universities was just starting.

Major projects for which there was an impelling need included the dual-lane controlled access highway 401 from Windsor to the Quebec border, and conversion of the Queen Elizabeth way to status of a fully controlled-access highway. Good progress was being made on the Burlington skyway bridge, to be completed in 1958.

There was a gap of 160 miles to close on the Trans Canada before 1961, and highway 2 must be relocated along the length of the seaway. There remained other necessary work on highways throughout the province, accounting for $55 million. It had been possible to start 10 miles this year of the Ottawa Queensway project that will form part of Trans Canada. This would be completed in four stages over a ten year period.

The Department of Highways was now engaged in a study of 64,533 miles of rural roads and 7,921 miles of urban streets, to be completed in 1958, to supplement its 'Plan For Ontario Highways', which will cope with the 170 per cent increase in motor vehicle traffic anticipated between now and 1975.

Quebec reported that highway expenditures for 1957-8 would approximately equal the $100 million appropriated last year for construction and maintenance. Added thereto is $30 million spent through the Departments of Mines, Colonization and Public Works for development and colonization roads, and bridges.

1956 had been a year favourable for road construction. Materials were in good supply and the labour force caused no problem. The shortage of professional engineers had created an embarrassing problem.

Last year road improvements were performed over a length of 3,800 miles. Construction and reconstruction covered over 970 miles of main highways and 2,830 miles of municipal roads. 826 miles of new asphalt and concrete pavements were completed and 245 miles of old roads resurfaced. Another 500 miles received a surface treatment. Now totalling a length of 43,643 miles, the province's road system includes 31,614 miles of improved roads, 31 per cent of which, or 9,700 miles, are hard surfaced.

The province pays special attention to rural roads. Over 22 per cent of municipal roads were improved and 12,000 miles remain to be improved. Last year nearly $25 million was allotted to rural road improvement. For summer maintenance of over 32,000 miles, a budget of $27 million had been appropriated this year. Winter maintenance covers 28,200 miles to be kept open, at a cost of $7.3 million.

Work had already started on the $40 million, 30 mile, six lane, toll expressway, the Montreal-Laurentian Autoroute. It will extend north from Montreal to the existing four lane highway north of St. Jerome. Completion is expected by late 1959 or early 1960. The Department was giving much consideration to south approaches to bridges spanning the seaway.

New Brunswick reported a 1957 budget for capital funds of $11.3 million, and revenue funds for roads, ferries, bridges, wharves and permanent highways of a further $15.8 million, with an additional $1 million for bridge construction. Totalling $28.66 million, this was one of the largest budgets expended by the province, which is going 'full-out' to live up to terms of the new Trans Canada agreement which expires in December 1960.

The 1957 season had been normal without too much change in the supply of materials and labour, though some difficulty was still being encountered in obtaining trained engineering personnel. Snow control was carried out on a full time basis on 11,727 miles of highway and for 630 miles on a part-time basis, out of a total of 13,000 miles of highway in the province.

This year 18 miles of new pavement were completed and some 60 miles of old pavement recap with hot asphalt mix. The seal coating and surface treatment program included 400 miles of seal coating and 200 miles of surface treatment, mostly by Department forces. Some 100 miles of grading and gravelling contracts were underway. Several so-called 'gaps' in the province's portion of the Trans Canada Highway include large bridges over the Saint John River. On structures, a contract had been awarded for the piers on the Fredericton crossing of the Saint John River, at a cost of $1.6 million. Another river crossing 100 miles up-river was in the design stage. The steel bridge over the Richebucto at Rexton was open for traffic, while the substructure for the Andover Bridge was completed. Bridges at Coles Island and Bel River Bar were open for traffic.

Work was underway on a second crossing of the Oromocto River near Gagetown, two miles upstream from the old structure. The bridge over the Madawaska River at Edmundston was well along with substructure completed and steel erection under way. Sixteen structures in various parts of the province costing some $10 million were under construction or projected.

Nova Scotia reported a 1957 highway budget of $12.8 million for maintenance, including $2.4 million for snow and ice control. The capital budget is $13.6 million including $1.9 million for the Trans Canada highway. The total budget is thus $26.4 million.

By the end of the current season the province will have built 34 miles and paved 3 miles of Trans Canada highway, and prepared for paving 233 miles of highway other than Trans Canada. In addition, bridges completed or under construction will number 46. Outstanding among projects was a highway and railway grade separation on the main entrance to Halifax, costing some $1 million, and a 10 mile limited access highway to the new Halifax International Airport. Both highway and airport will be completed by the fall of 1958.

Tenders would soon be called for a $3 million dam over the Annapolis River to protect a marshland area and to replace a highway bridge. This was a joint federal-provincial project. In the planning stage was a Trans Canada crossing of a 3,000 ft. ocean channel to the Bras d'or Lakes, costing $7 million.

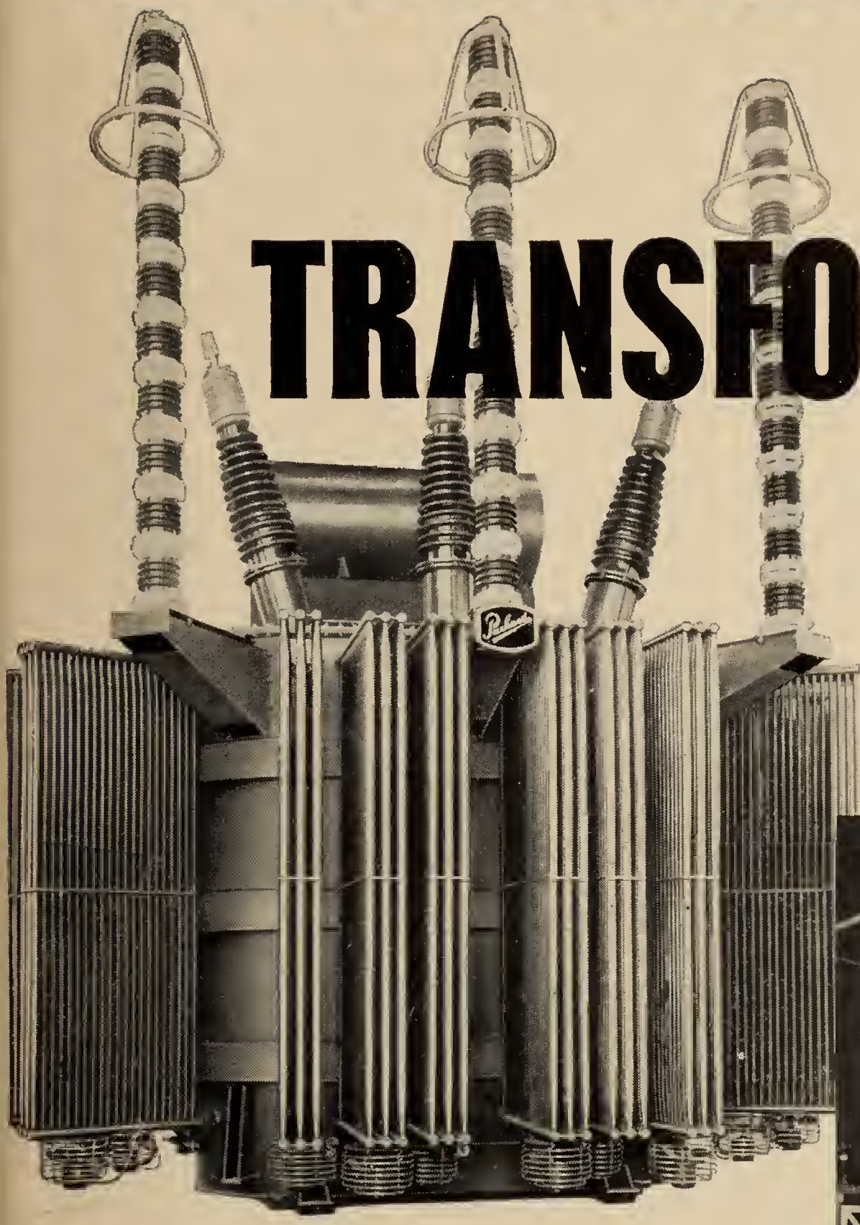
Other Highway Construction: Reports from the Provinces of Newfoundland and Prince Edward Island, and from the Development Engineering Branch, Dept. of Public Works at Ottawa dealing with overall progress on the Trans Canada Highway, were not available to the Journal.

Tallamy Guest Speaker

Bertram D. Tallamy, U.S. federal highway administrator, one of the best known figures in the highway world, was guest speaker at the second day's luncheon. "We are building 41,000

PACKARD

TRANSFORMERS



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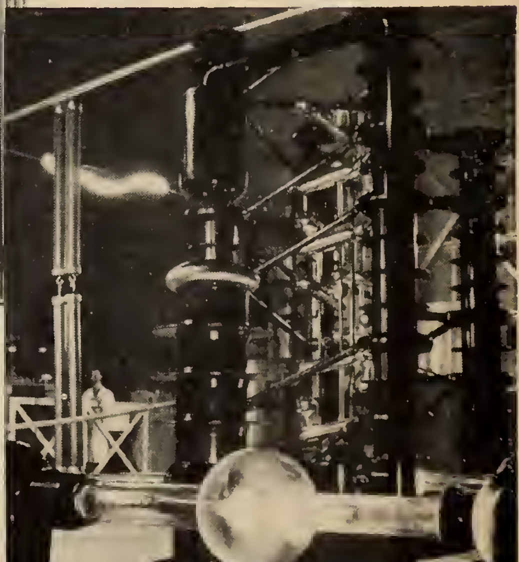

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miles of new express highway to link all states and most major cities in United States", he stated. "This network will touch all bordering Canadian provinces and connect with traffic arteries in the Dominion. Good highways pay their way many times over in reduced accident rates and economical transportation, but also in stimulation of industry, commerce and employment and in benefits to the tourist industry and agriculture".

The U.S. program was geared to accommodate the traffic of 1957 of 100 million vehicles compared with 65 million today, he pointed out.

Technical Sessions

A forum dealing with soils and materials was conducted on the second day, chaired by R. M. Hardy, dean of engineering, University of Alberta, with four papers on earthwork, bituminous mix and concrete mix. Concurrently another forum dealt with economics, finance and administration, chaired by J. H. Perry, director, Canadian Tax Foundation, with papers on personnel, prequalification, road classification and highway statistics. An afternoon session was devoted to planning and design, with D. A. Larmour, Saskatchewan Department of Highways in the chair and with three papers dealing with design and computation. Concurrently another group under W. A. Bryce, general manager, Canadian Highway Safety Conference, heard three papers on accidents and safety.

On the third day a morning session was devoted to a symposium on frost action, arranged by a sub-committee on soils and materials. Three papers were presented, dealing with alleviation of frost action. Elsewhere a panel discussion on public relations policies and highway department practice was held under the Hon. R. D. Robertson, minister of Public Works of Manitoba, as moderator.

The afternoon session was chaired by John Walter, director of planning and design, Ontario Highways Department. Delegates heard three papers on construction and maintenance. This was followed by a panel discussion on bridge construction and maintenance, with three papers presented.

In the evening members were guests of the Saskatchewan Government at a barbecue held at the Dominion Forestry Farm. It was announced that the next CGRA convention would be held at the Queen Elizabeth Hotel, Montreal, Sept. 30 to Oct. 3, 1958.

Calendar

Tool Engineers

An invitation for technical papers has been extended by the National Program Committee of the American Society of Tool Engineers. Accepted papers will be presented at the 26th Annual convention of A.S.T.E., to be held April 1958.

Selection of papers for the coming 25th (Silver Anniversary) Annual Convention next March has been completed and a number of outstanding papers from industry will be presented at the anniversary event in Houston, Texas.

Plant Maintenance

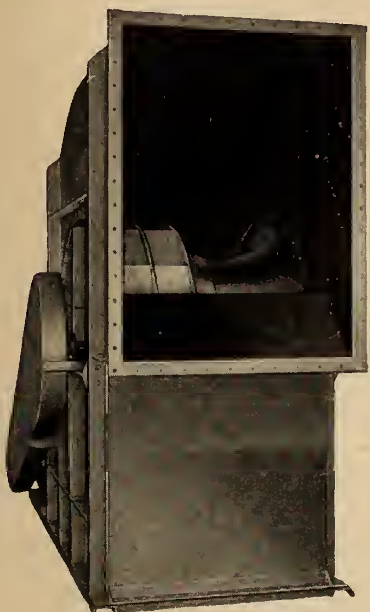
The ninth plant maintenance and engineering Conference will be held in Chicago, January 27-30, 1958. Prevention of air and water pollution and the impact of automation on maintenance top the list of subjects to be discussed.

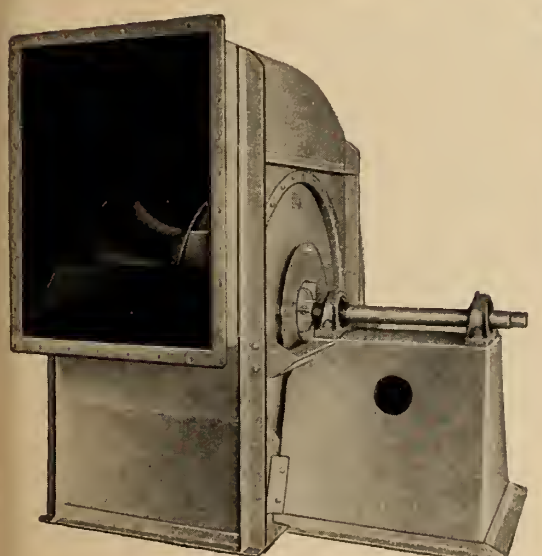
Registration cards and hotel information may be obtained from Clapp and Poliak, Inc., Madison Ave., New York 17, N.Y.

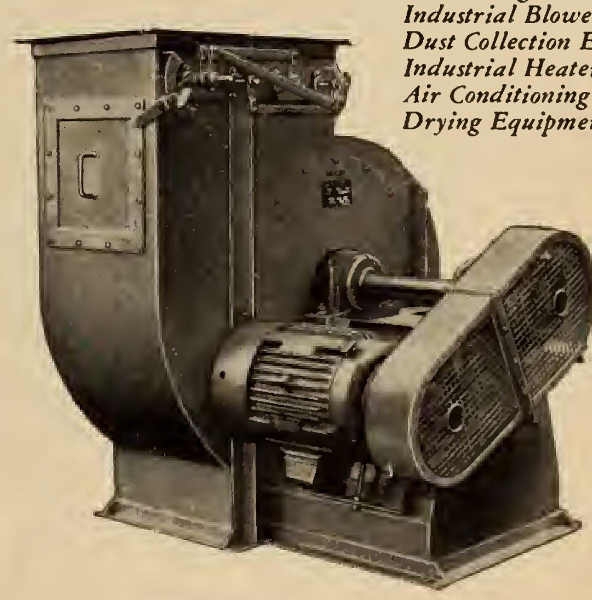
Testing Materials

The American Society for Testing Materials, included among its list of national meeting dates Committee Week, to be held at the Hotel Statler, St. Louis, Mo., from February 9-15.

Address of the Society of Testing Materials is: 1916 Race Street, Philadelphia, Pa.







Library Notes

Additions to the Institute Library

Reviews, Book Notes

Standards

BOOK NOTES

Prepared by the Library, The Engineering Institute of Canada

*Book notes marked by an asterisk have been provided through the courtesy of the Engineering Societies Library in New York.

ACCOUNTING FOR NON-ACCOUNTANTS

Intended for those who are not accountants, but who require some knowledge of accounting principles and techniques, this book should prove useful to many of our members.

The objective of the book is to explain accounting procedures, and four chapters deal with the understanding of accounting data. The other topics covered are: recording and classifying financial transactions; adjusting and summarizing accounts; types of accounting required by merchandising and manufacturing firms; accounting procedure required by partnerships and corporations.

The author has included sample entries to illustrate his statements, and this book should do much to help clarify many of the mysteries which often appear to surround account books and accounting departments. (J. N. Myer. New York, University Press, 1957. 235p., $5.00.)

ANALYSIS OF INDETERMINATE STRUCTURES

In his earlier book, Elementary Theory of Structures, the author considered only determinate structures, and in this volume he shows the basic method of approach to the problem of indeterminate structures, and gives their application to some of the more common types of such structures.

The subject is considered under the following headings: elastic deformation of determinate structure; beams constrained over supports; analysis of rigid frames; analysis of statically indeterminate trusses; analysis of elastic arches; continuous and long-span bridges; secondary stresses in framed structures. The author illustrates all his statements by means of many worked examples. (J. C. Grassie. Toronto, Longmans, Green, 1957. 418p., $9.00.)

Members may borrow the books mentioned in these Notes on application to the librarian. Two books may be borrowed for two weeks.

LIBRARY HOURS

Monday to Friday

9 a.m. — 5 p.m.

Saturday

9 a.m. — 12 noon

*AUSTRALIA-NEW ZEALAND CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING, PROCEEDINGS, 1956

The proceedings of the Second Conference are made up of over twenty papers on various aspects of the theory of soil mechanics and the practice of foundation engineering. One group of three papers is devoted to the earth dam at Cobb Hydro-electric Power Development, another to studies of unsaturated soils. Subjects of some of the other papers include rapid consolidation tests; a direct shear machine with automatic recorders; shear strength of rockfill; pore pressure and shear strength tests on earth dam materials; selection of design values from shear test results; and protective systems for seepage control in earth dams. (Wellington, New Zealand Institution of Engineers, 1957. 207p., £3.12.)

*BASIC AUTOMATIC CONTROL THEORY

The basic theory pertinent to the analysis and synthesis of linear control systems having only fixed, lumped parameters and subject to input commands and disturbances which can be specifed with certainty is the subject of this college textbook. Among topics covered are types of control systems; ultimate-state, frequency and time response; and introduction to use of the analogue computer. (G. J. Murphy. Toronto, Van Nostrand, 1957. 557p., $9.75.)

BASIC PHYSICS

As its title implies, this is a basic textbook, covering the fundamentals of classical and modern physics at an intermediate level. It is composed of two volumes, bound together.

The materal is organized in a "spiral" manner, and the first volume, complete in itself, presents an overall picture of the subject, while the second volume expands certain topics, and covers them in a more analytical manner. There are numerous illustrations.

Every attempt has been made to make the book as up-to-date as possible and to treat the subject in the "modern manner". The author has based his text on a high school physics course which he has taught for the last ten years. (Alexander Efron. New York. Rider, Toronto, Pointon, 1957. 692p., $7.60.)

*BIBLIOGRAPHY AND ABSTRACTS ON ELECTRICAL CONTACTS (1956 SUPPLEMENT)

The current supplement raises to over 2400 the total number of references in the 1951 cumulation and the subsequent supplements. The references, many including extensive abstracts, are taken from some 250 periodical publications, of which a list is provided. References to pertinent books are also included, and subject and author indexes are provided as the basic arrangement is chronological. (Philadelphia, American Society for Testing Materials, 1957. 40p., $1.75. (A.S.T.M. stp. no. 56-K).).

*THE CASTING OF STEEL

Prepared by a group of authorities from the British steel casting industry, this book provides a balanced view of the whole subject, from basic principles and their applications to practical problems in the foundry. The opening chapters deal with the properties of molten steel, solidification, the melting process, and refractories. Detailed descriptions of pattern making, mold preparation, and of the casting process are included, with separate chapters devoted to centrifugal and investment casting. The last part of the book covers heat treatment, properties, specifications, and testing. (Ed. by W. C. Newall. London, Pergamon Press, 1955. 599p., illus., £5.5.0.)

LIBRARY NOTES

CLOSED CIRCUIT TV SYSTEM PLANNING

The many possibilities of closed circuit television systems are becoming more and more apparent, and this book is intended for those in management who are contemplating installing such a system.

The book is divided into three parts, the first of which explains the various types of systems already in use in such places as manufacturing plants, banks, freight yards, department stores, schools, hospitals, etc., and shows how they can be used for sales conferences, product displays, etc.

The second and third parts explain how closed circuit television works, how to organize a system, the equipment and space required, cost of installation, man power requirements, etc. The authors also discuss the limitations of a system.

Both authors have had many years' experience in the television field, and this book should prove extremely useful. (M. A. Mayers and R. E. Chipp. New York, Rider, Toronto, Pointon, 1957. 250p., $10.50.)

*A CONCISE GUIDE TO PLASTICS

This book describes all known American commercial plastics, including those still in the laboratory stage. It covers the selection, use, and forms of plastics, with discussions of those best suited to particular products. The information includes basic data on strength, properties, processes, production, and prices. Future trends and probabilities in plastics are also discussed, including new materials and production methods. (H. R. Simonds. New York, Reinhold, 1957. 318p., $6.95.)

DISCOVERY OF THE UNIVERSE

The last few chapters of this translation of a 1951 French edition have been expanded to give a clearer picture of contemporary astronomy, and the last one dealing with post-war developments is completely new. The bibliography has also been enlarged, and new illustrations added.

The author, at present at the Mount Stromlo observatory in Australia, traces the development of astronomy from earliest times to the present. The first chapter serves as an historical introduction, outlining the contributions of antiquity and the Middle Ages, while the remaining chapters trace the development of modern astronomy from the time of Copernicus.

The author has concentrated on the astronomers' ideas rather than their biographies, and has shown how in astronomy as in other fields the discoveries of each age have been made possible by the work which has been done before. A brief analytical bibliography is included, and there are detailed name and subject indexes.

The translation, by Bernard Pagel, reads like original English. (Gerard de Vaucouleurs. Toronto, British Book Service, 1957. 328p., $6.00.)

DRY-BATTERY RECEIVERS WITH MINIATURE VALVES

Written for the receiver designer faced with problems of using directly-heated valve types, this book will also be of interest to the service technician and the amateur radio enthusiast.

Dry-battery operated receivers are popular on account of their small size and light weight, and their reliability and sensitivity. They can be used in short wave and V.H.F. range receivers where transistors as yet cannot. They are also cheaper.

Included are valve data and characteristics of miniature valves for dry-battery operation, electronic tuning indicators, and descriptions of eight suitable circuits, including AM/FM designs, push-pull output stages, and sensitivity values for normal and reduced supply voltages. (E. Rodenhuis. Eindhoven, Philips, 1957. 238p., $4.95.)

ESTIMATING GENERAL CONSTRUCTION COSTS, 2ND ED.

The author, a specialist in estimating for building and heavy construction, presents the method he has devised in the last twenty-two years for estimating direct production costs in earthwork, reinforced concrete work, structural steel work, masonry and carpentry.

The system requires no previous knowledge of estimating, and its key lies in finding the productivity percentage and applying it to three tables to find shift cost, output range, and unit cost. From these it is easy to estimate the total cost for any job. The system can be used in any part of the country, and the figures do not go out of date.

This should prove a useful and interesting addition to the literature on estimating. (Louis Dallavia. New York, Dodge, 1957. 197p., $8.50.)

FADS AND FALLACIES IN THE NAME OF SCIENCE

The subtitle of this second edition "The curious theories of modern pseudo-scientists and the strange, amusing and alarming cults that surround them. A study in human gullibility" gives an accurate picture of its contents. The author has set out to expose the pseudoscientific ideas, of which there are so many currently in vogue, and has obviously done a great deal of research on the subject, as can be seen from his references in both the text and the appendix.

Some of the topics discussed are: the hollow-earth theory; flying saucers; the Fortean Society; dowsing; Atlantis; the Great Pyramid; food fads and medical cults; and Bridey Murphy and hypnotism.

The publication of this book is going to annoy a great many people whose pet theories are here exploded by a reasoned scientific argument. The variety of strange cults and theories brought to light by Mr. Gardner is truly amazing. (Martin Gardner. New York, Dover, 1957. 363p., $1.50.)

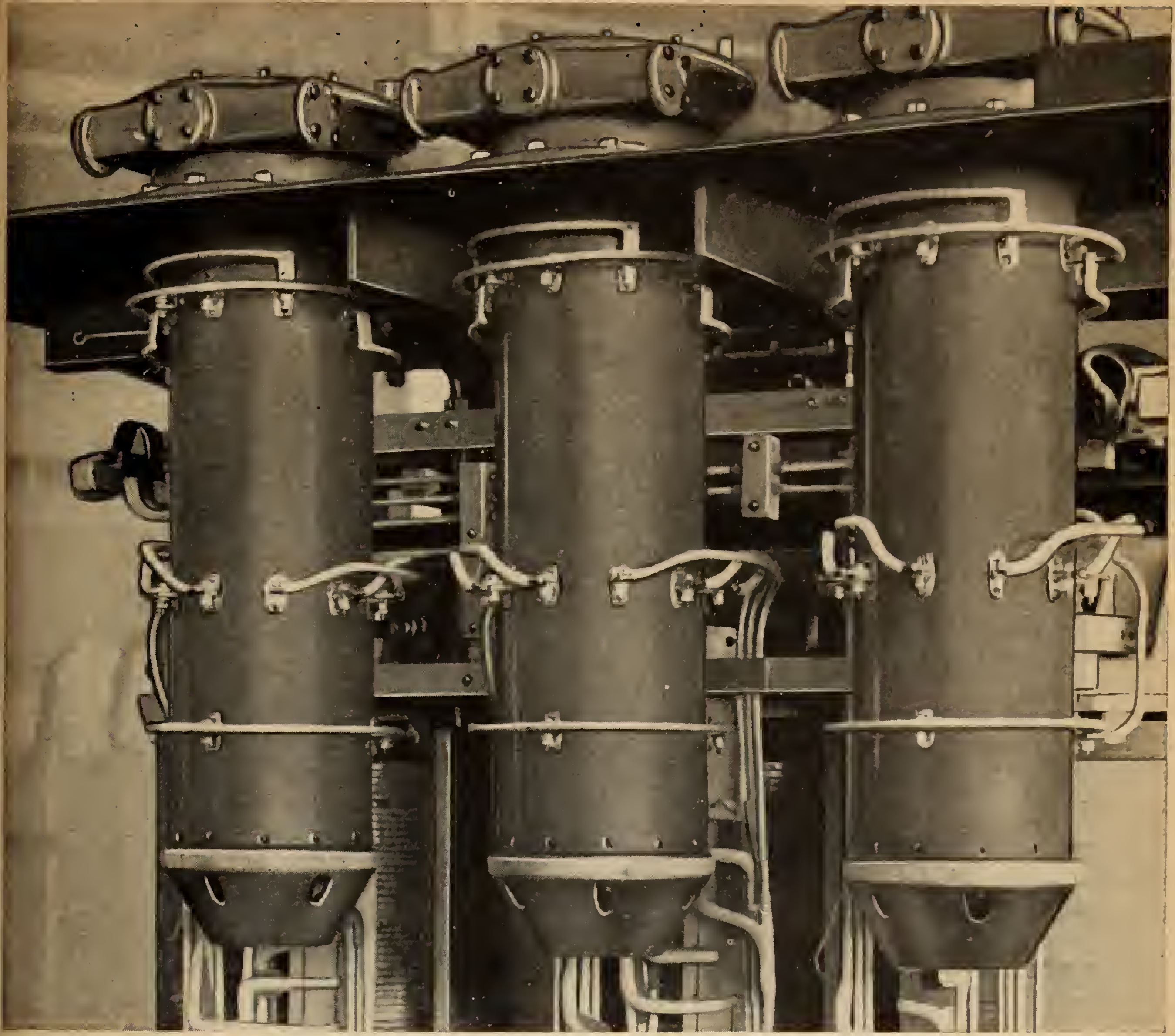
HANDBOOK OF CHEMICAL DATA

The main purpose of this pocket-size handbook is to make available to chemists in a compact, condensed form the information they need in their work. The majority of the tables are concerned with physical constants and properties. The editor-in-chief is the President of Industrial Processes Development Ltd. in Kingston, Ontario. (Ed. by F. W. Atack. New York, Reinhold, 1957. 629p., $6.75.)

INSTALLING ELECTRONIC DATA PROCESSING SYSTEMS

A sequel to the author's earlier work on planning for the use of electronic data processing (EDP), this volume commences with the placing of the order, and considers such topics as planning the installation programme, programming, installation, conversion to the EDP system, and the early phases of operation when problems necessarily arise. It covers the related problems of fitting EDP into the existing organization, and of training personnel. It shows how the high cost of installation can be controlled.

It is written for those with little knowledge of electronic computers, and includes a case study based on the experiences of several companies. References are included for further reading. (R. G.



● LIBRARY NOTES

Canning. New York, Wiley, 1957. 193p., $6.00.)

*AN INTRODUCTION TO FLUID MECHANICS AND HEAT TRANSFER

Emphasizing the common theoretical basis of heat transfer and fluid mechanics, this text presents first the fundamental ideas of fluid flow, viscosity, heat conduction, diffusion, energy and momentum principles, and dimensional analysis. These ideas are then developed in terms of practical applications: flow in pipes and channels, pumps, heat exchangers, etc. Later chapters deal with more specialized topics such as turbulence, forced convection, solid particles in fluid flow, flow in packed beds, condensation and evaporation. (J. N. Kay. Toronto, Macmillan, 1957. 309p., $6.35.)

INTRODUCTION TO WORK STUDY

Written originally for people attending courses in work study run by International Labour Office technical assistance missions, the object of the book is to describe the basic techniques of work study, and give examples of their application. Those interested in more complex techniques will find references to more advanced texts in the biblography.

The first chapters of the book consider the general problem of the causes of low productivity and the management techniques which can be used to overcome them, including work study. The following three chapters discuss work study and its application, pointing out the necessity for good human relations and working conditions.

The second and third parts of the book deal with method study and work measurement, the two main techniques of work study.

The appendices includes notes on using this as a text book, a glossary of the management terms used, and the bibliography already referred to. All the usual diagrams, charts, etc. are included. (Geneva, International Labour Office, 1957. 349p., $3.50.)

MEASUREMENT OF SOIL PROPERTIES IN THE TRIAXIAL TEST

The authors state in their preface that "current methods of stability and deformation analysis call for a range of test data which can be obtained conveniently only with the triaxial apparatus". Consequently, they have limited their book to a treatment of the triaxial test only, and the problems which arise in its use in the laboratory. They emphasize that the results are of use only if the samples are truly representative, and the geology of the site is understood.

The first introductory chapters discuss the basic principles underlying strength and deformation measurement in relation to the practical problems found in soil mechanics. Part II described the main features of the triaxial apparatus.

The third section of the book describes standard tests, including all those likely to be needed by an engineer dealing with soil problems. The special tests in part IV are only likely to be found in a research laboratory. Included in the appendices are a four-page bibliography and a list of manufacturers (British) of the equipment described in this book. (A. W. Bishop and D. J. Henkel. Toronto, Macmillan, 1957. 190p., $12.00.)

OXFORD DESK ATLAS OF THE WORLD

A new, compact, atlas in which particular emphasis has been placed on Canada, this volume was prepared with Canadian assistance.

There are twenty-eight pages of maps of Canada showing, in addition to the usual topographic features: population distribution according to the 1956 census; major railroads, roads, ports and airports; vegetation; climatic regions; soils; agriculture and forestry; geology; and minerals and industry. There is also a separate gazeteer for Canada, containing 5200 entries, and a special map of the St. Lawrence Seaway area.

The rest of the world is covered in considerable detail, and special mention should be made of the liberal use of colour throughout the atlas, and the special shading used which gives an almost three-dimensional effect to the map. (Advisory eds. E. G. Pleva and Spencer Inch. Toronto, Oxford University Press, 1957. 137p., $3.95.)

PETROLEUM: PREHISTORIC TO PETROCHEMICALS

This is the story of petroleum from its geological and archaeological beginnings to the modern petroleum and petrochemical industries, placing particular emphasis on Canadian conditions, and the phenomenal growth of the industries here.

The author, writing for both the general reader and the petroleum engineer, commences his book by pointing out the importance of petroleum in the modern world. Following this he discusses the history and nature of petroleum, and its occurrence. The next group of chapters covers the location of petroleum, drilling, production and transportation.

The various processes in refining are covered as are the resulting products, including petrochemicals, and their uses.

The author is the head of the Information Section of the Technical Division of Imperial Oil Ltd., and while much of his material necessarily reflects the history and operation of his organization, the book does present an overall picture of the Canadian Industry. (G. A. Purdy. Toronto, Copp Clark, 1957. 492p., $12.50.)

What Goes On

(*continued from Page* 1836)

Trade Mission to Britain

A trade mission comprising leading representatives of Canadian business and industry, labour and resources associations, left Montreal late in November for Britain. The visit was to last until December 18, during which time the party was scheduled to have preliminary talks in London with cabinet ministers, government officials and members of the Dollar Exports Council, and to make a tour of industrial centres in England, Scotland, Wales and Northern Ireland.

The Hon. Gordon Churchill, minister of trade and commerce of Canada, who is heading the mission, has expressed the belief that this program, prepared by the British Government in consultation with Canada, will enable members of the mission to obtain a good impression of the productive capacity of the United Kingdom. The contacts, it is expected, may result in the placement of orders for British goods, and in the creation of a favourable climate for the flow of merchandise to Canada.

Members of the trade mission are: James S. Duncan, H.E.P.C., of Ontario; Robert J. Askin, M.E.I.C., Abitibi Power and Paper Company Limited; A. G. Bailey, Bailey-Selburn Oil and Gas Limited; Lt.-Col. Herve Baribeau, Baribeau & Son; John L. Bonus, Canadian Association of British Manufacturers and Agencies; Lawrence C. Bonnycastle, Canadian Corporate Management Company Limited; Leonard W. Brockington, Odeon Theatres (Canada) Ltd.; E. A. Bromley, Canadian National Railways; J. Arthur Clark, Maritime Asphalt Products Ltd.; H. A. Cresswell, Canada Steamship Lines Ltd.; Hugh Crombie, M.E.I.C., Dominion Engineering Co. Ltd.; Robert Drummond, M.E.I.C., Angus Robertson Ltd.; M. A. East, John East Iron Works Limited; S. S. Fletcher, Robert Simpson Company Limited.

Allan D. Foulis, M.E.I.C., Foulis Engineering Sales Limited; Kenneth F. Fraser, B.C. Packers Limited; Geoffrey A. Gaherty, M.E.I.C., Montreal Engineering Co. Ltd., R. W. Ganong, Ganong Brothers Limited; B. B. Gattie, British Columbia Lumber Manufacturers' Asssociation; Crawford Gordon, Jr., A. V. Roe (Canada) Ltd.; R. E. Heartz, M.E.I.C., Shawinigan Engineering Co. Limited; Bruce Hill, E.T.F. Tools Limited; Gordon W. Hunter, Department of Defence Production; W. L. Hutchison, M.E.I.C., Moffats Limited; J. R. Jenkins, T. Eaton Co. Ltd.; J. G. Johnston, Johnston Everson and Charlesworth Ltd.; John D. Leitch, Toronto Elevators Limited; Harold V. Lush, Supreme Aluminum Industries Limited, president, Canadian Manufacturers Asssociation; Frederick C. Mannix, Mannix Limited, Ian F. McRae, M.E.I.C., Canadian General Electric Co. Ltd.; H. P. Miller, Canadian Pacific Railway Company Ltd.; Trevor F. Moore, Imperial Oil Limited; F. M. A. Noblet, International Nickel Co. Ltd.; James Patterson, Interprovincial Farm Union Council; William Perlin, I. F. Perlin and Company; Andre Piche, Reynolds Aluminum Company of Canada Limited; Col. Roger Roberge, Ottawa.

Frederick G. Rutley, M.E.I.C., The Foundation Company of Canada Ltd.; George P. Schollie, Canadian Labour Congress; Henry Sissons, Hydro Electric Power Commission of Ontario; Wallace C. Smith, Lunenburg Sea Products Ltd.; Donald M. Stephens, M.E.I.C., Manitoba Hydro Electric Board; E. B. Stocker, Canadian Importers and Traders Association; Humphrey B. Style, John Inglis Company Ltd.; John H. F. Turner, Bank of Montreal, Eric J. Wain, Canadian Industries Limited; Victor C. Wansbrough, Canadian Metal Mining Association; J. B. White, Aluminum Company of Canada, Limited; David M. Woods, Gordon Mackay and Company Limited.

Canadian Shipbuilding

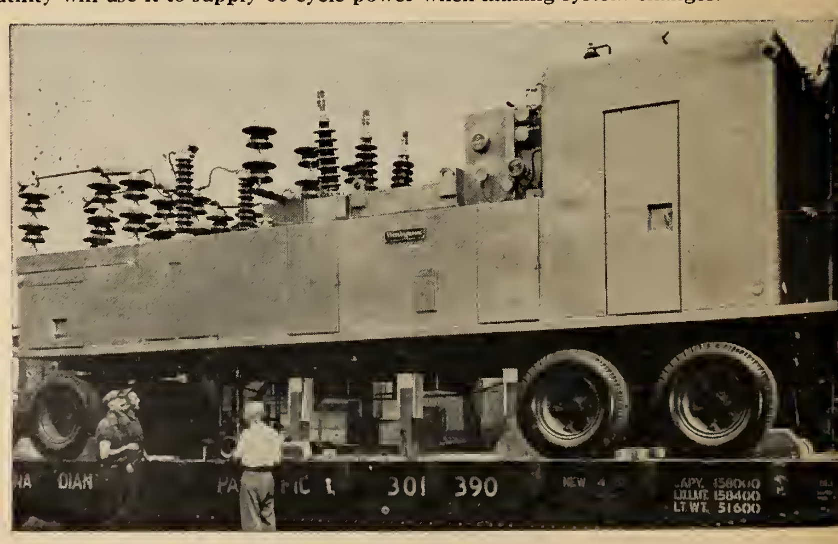
Canada's present-day shipbuilders have moved in step with changing and exacting demands of a mechanized age, reports the Canadian Shipbuilding and Ship Repairing Association, in its Newsletter No. 1 of a new series. The industry is producing steam-powered ships, oil-burners, giant tankers, rugged icebreakers to penetrate the northern waters. It is adapted to the most modern techniques, alert to the new techniques to come.

NRU Reactor in Operation

The NRU reactor of Atomic Energy of Canada Limited went into operation at Chalk River on November 3. The start-up culminates six years of intensive effort in design, engineering development and construction. After several weeks of test experiments at low power, the power was to be increased to the rated capacity of 200,000 kilowatts thermal. This rated capacity is approximately five times as great as that of the NRX reactor.

The NRU reactor is a triple-purpose reactor, and this has contributed greatly to the complexity of its design and to its cost. It will provide research, testing, and experimental facilities required for the development of nuclear power; it will produce plutonium; and it will produce radioactive isotopes.

A complete substation on wheels was supplied by Canadian Westinghouse to the West Kootenay Power and Light Company this year. The unit is equipped with a high-voltage disconnect switch, lightning arresters, a 6500-kva. transformer, low-voltage circuit breaker, metering and control equipment. The British Columbia utility will use it to supply 60-cycle power when making system changes.



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